UNITED STATES

DEPARTMENT OF THE INTERIOR

FINAL
ENVIRONMENTAL STATEMENT
Volume 2 of 3

Proposed

1974 OUTER CONTINENTAL SHELF

OIL AND GAS GENERAL LEASE SALE

OFFSHORE LOUISIANA

OCS SALE No. 36
FES 74 –41

Prepared by the

BUREAU OF LAND MANAGEMENT

Director

For sale by the Superintendent of Documents, U.S Government Printing Office
Washington, D.C. 20402

VOLUME II

Page

III. Offshore Oil and Gas Operations

A. A Description of Oil and Gas Operations Including a Timetable for this Proposal

1. Geophysical Exploration

a. Industry

In order to locate hydrocarbon deposits, the oil industry must analyze the substructure of the continental shelf. The prime objective of the structural analysis is to locate geologic structures, which are favorable for the accumulation of petroleum. A knowledge of the subsurface geologic environment is also necessary to detect near surface conditions, such as recent faulting or high pressure zones, which are potential hazards to exploration and production operations. Once hazardous conditions are identified, drilling programs are modified to assure safety of operations.

Prior to a call for nomination of lease sale tracts, industry normally conducts regional geophysical surveys of an area of interest. These surveys provide a network of modern state-of-the-art common depth point (CDP) seismic lines on approximately a 4-mile-by-4 mile grid spacing to provide data for reconnaissance mapping. In some cases an even closer 2-mile-by-2 mile line spacing may be used. After the tracts have been nominated, industry initiates the collection and interpretation of even more detailed seismic data in order to intelligently evaluate potentially productive tracts, and formulate reasonable bid offers.

In seismic exploration, a ship travels along a predetermined path, towing signal generating and recording equipment. The signal generated by the energy source is a series of small amplitude seismic pulses that travel at the speed of sound through the water and sediment below, where they are reflected and refracted by the underlying strata. An array of sensitive detectors towed by the vessel receive incoming seismic waves which are then recorded on magnetic tape. After extensive processing, the recordings are displayed in the form of vertical cross-sections. The seismic profiles are then interpreted to identify those areas where the sediments are arched, faulted, pierced by salt or shale domes, where they thicken or thin, and where reef structures occur. By assembling cross-sections run in various directions, a three-dimensional view can be constructed, indicating the location, size and shape of geologic structures favorable to oil and gas accumulation. This information is normally displayed as a series of subsurface seismic contour maps. Recently it has been reported that gas accumulations may be interpreted directly from seismic records by a technique called "bright sport". This system is relatively insensitive to water depth.

During the early years of offshore exploration, underwater explosive charges were used as the seismic energy source. Because the use of explosives presented a hazard to equipment, men and marine life, new methods and gear were developed that provide excellent seismic

data with no harmful effects on the marine environment. These modern devices, which include sparkers, air guns and gas guns have become widely accepted and account for over 95% of marine seismic energy sources currently in use.

In addition to the deep penetration CDP seismic reflection data, some companies purchase and interpret shallow penetration high resolution geophysical data to locate potential geologic hazards such as unstable bottom sediment conditions and fault zones. A typical high resolution data acquisition system is illustrated in Figure 1.

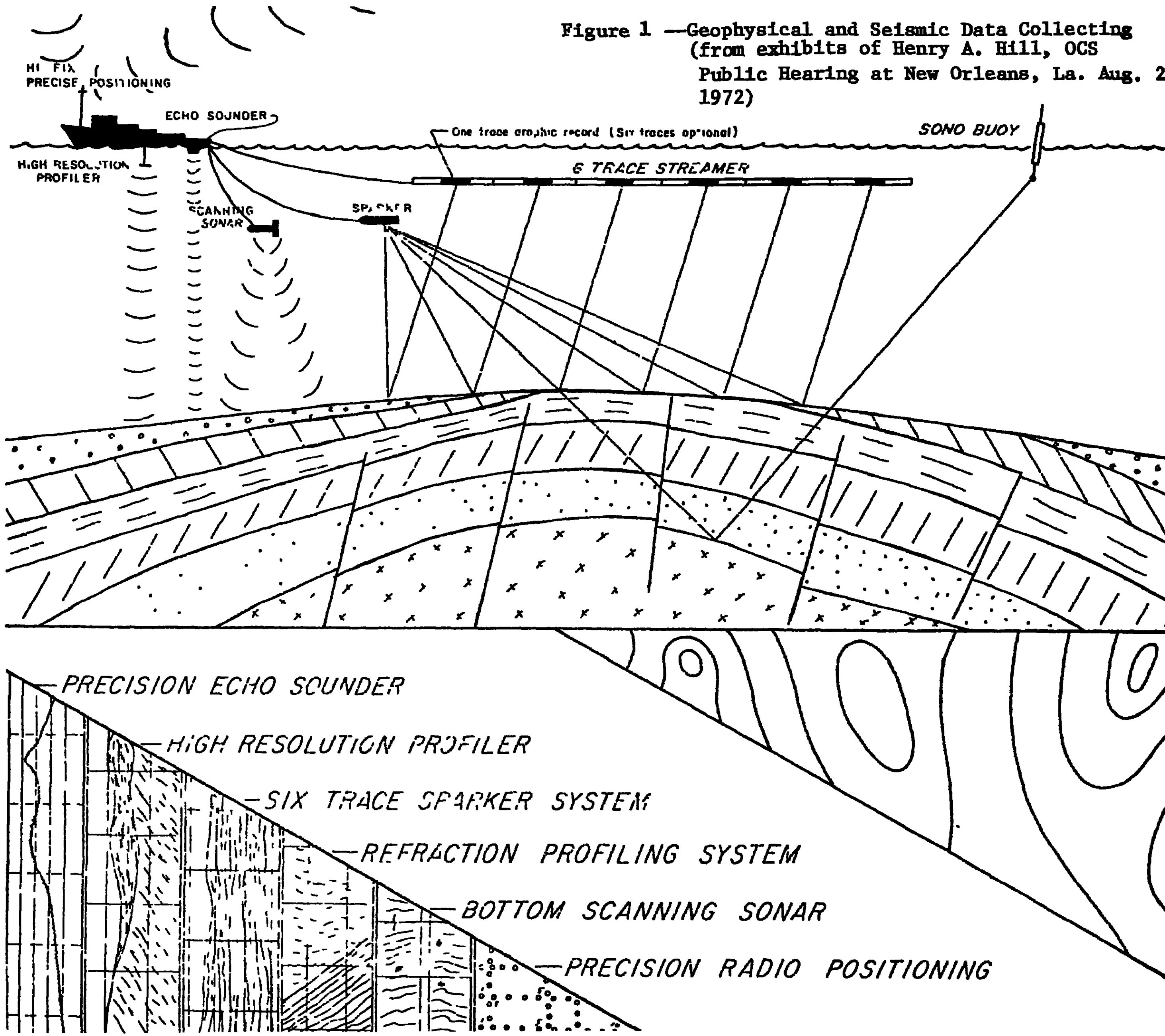
b. U.S. Geological Survey

The U.S. Geological Survey, Conservation Division, has acquired from industrial sources approximately 50,000 line miles of modern CDP seismic data offshore Louisiana in support of the Federal offshore leasing program. These data extend seaward to the 1000-meter water depth contour. The data provide definitive information on size, shape, type, and depth of prominent structural features in the area of the proposed general lease sale.

The structural information derived from seismic data is used as a basic input in selecting tracts to be offered for leasing and also shows the relative merits of potential traps for oil and gas.

Regional seismic interpretations have shown salt and/or shale domes, together with their associated faulting will be the types of

Figure 1 —Geophysical and Seismic Data Collecting (from exhibits of Henry A. Hill, OCS Public Hearing at New Orleans, La. Aug. 23 1972)



structures most likely to be encountered within the northern Gulf province. These structural features are considered prime locations for the accumulation of hydrocarbons.

Detailed seismic interpretations of each proposed sale prospect are being prepared by the U.S. Geological Survey to support the economic evaluation of the acreage.

High resolution geophysical data which reveal shallow geologic structures, sediments, and faults are used to predict, and thus minimize, any hazards to drilling operations and possible consequent dangers to the environment from pollution. This information will also be used as a guide in regulating platform and well placements as well as drilling procedures. This subject will be discussed more completely under "Mitigating Measures" section V.

Approximately 25,000 line miles of high resolution data, comprising a 2x2 mile and 1/2x1-1/2 mile survey grid over the Louisiana OCS and slope (from the 3 mile line out to the 600 meter water depth contour) have been collected. In addition, procurement action will be initiated by the USGS to acquire the necessary data covering all tracts to be offered.

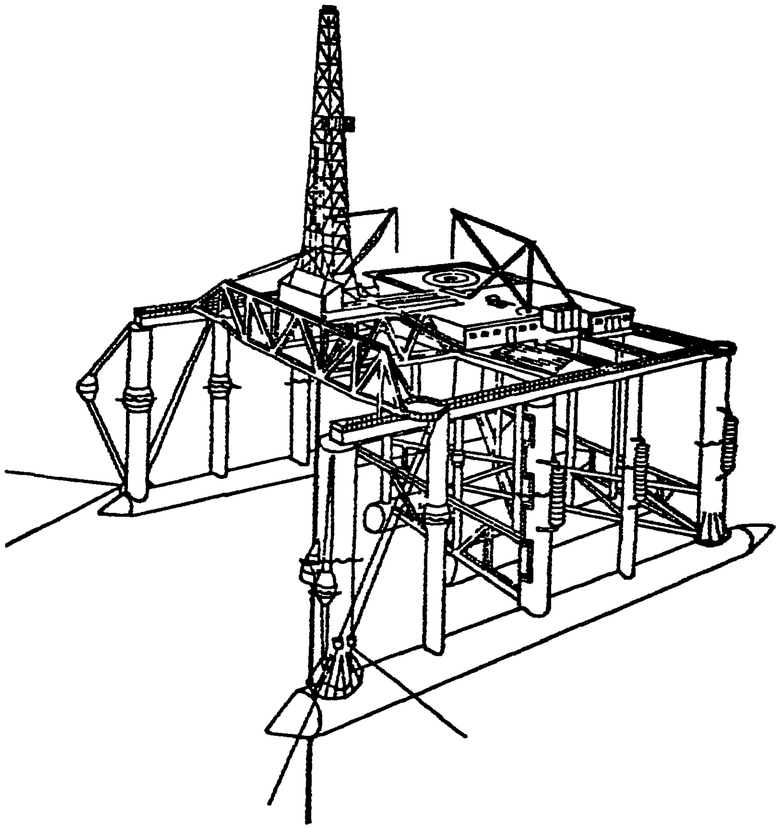
2. Exploratory Drilling

a. Drilling Phase

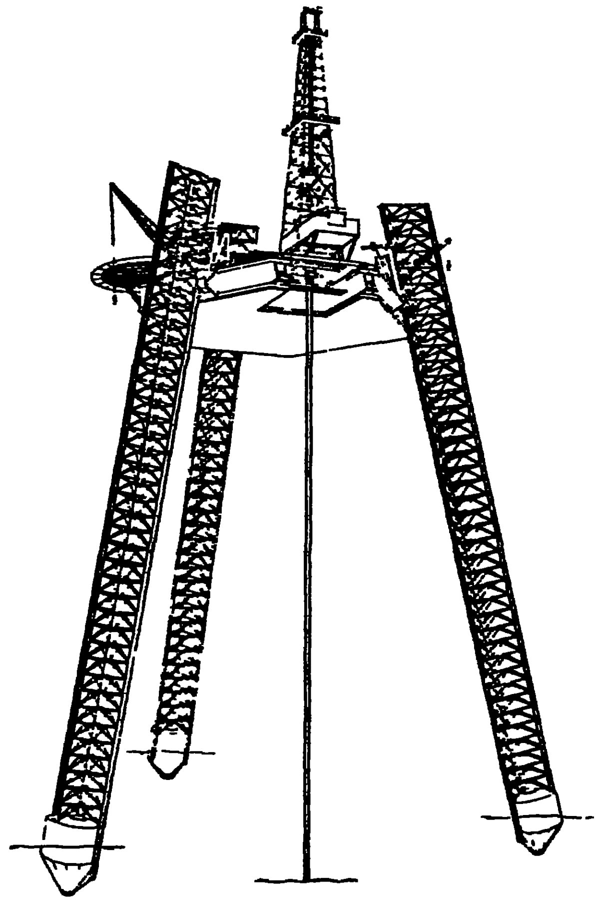
Most offshore exploratory drilling is accomplished with the use of mobile drilling rigs that can be moved from one location to another with relative ease. These mobile rigs include those that are bottom-supported while drilling and those floating rigs that are held in position over the site by anchors.(Figure 2).

The bottom supported rigs (jack-ups) are floated from one location to another, and are most vulnerable to damage or loss while in transit. Shallow (less than 300 feet) water exploratory drilling is commonly carried out using a "jack-up" type drilling rigs, while deeper waters require the use of semi-submersible rigs or drill ships. The jack-up rig is towed into position and the legs jacked downward to contact the bottom and lift the platform 30 to 50 feet above the water surface.

The semi-submersibles are large, advanced-design floating rigs that have better motion characteristics in rough seas than do ships or barges. These rigs are floated to the site, partially submerged and held in place by anchors. These units can work in water depths up to 1000 feet and beyond. At this depth, (37 of the tracts being offered have water depths from 300 to 500 meters) the major problem is keeping the drilling vessel properly aligned with the drill hole on the sea floor. One method has been to connect the wellhead (on



Once anchored in place, the semi-submersible is used to drill wildcat or exploratory wells in depths up to 1,000 feet and beyond.



With elevating legs, the jack-up rig can be floated to location and then raised or jacked up on the legs to appropriate height above water. This rig is normally limited to about 300-foot water depths.

Figure 2.: Exploratory Drilling Rigs (From "The Offshore Search for Oil and Gas Exxon Background Series No. 2R, November, 1972).

he seafloor) with the drillship by a drilling riser pipe which is ensioned at the top to maintain its structural integrity. The ension requirements can be reduced by attaching buoyant material :o the riser; in fact, analysis indicates that buoyant risers can ›e designed for water depths of 3000 feet (approximately 915 meters). 7inds, waves and ocean currents tend to push the drillship off location ·egardless of how good the mooring system. This can put excessive ;tresses on the riser. One company uses an acoustic position reference ;ystem whereby acoustic signals from an acoustic beacon located near :he wellhead on the seafloor are received by three shipboard hydrophones. [n use, the vessel's position is determined by comparing, at each of the three shipboard hydrophones, the signal emitted by the seafloor beacon. The correct position, with reference to the wellbore, is shown on the shipboard console viewing screen and the vessel kept in position by adjusting mooring lines or using the ships engines plus special horizontal thruster engines. If, for some reason the drillship should have to move off location, the seafloor beacon is used to reposition the vessel upon return.

A diagram of the buoyant riser, acoustic position reference system and submarine blowout preventers is shown in Fig. 3.

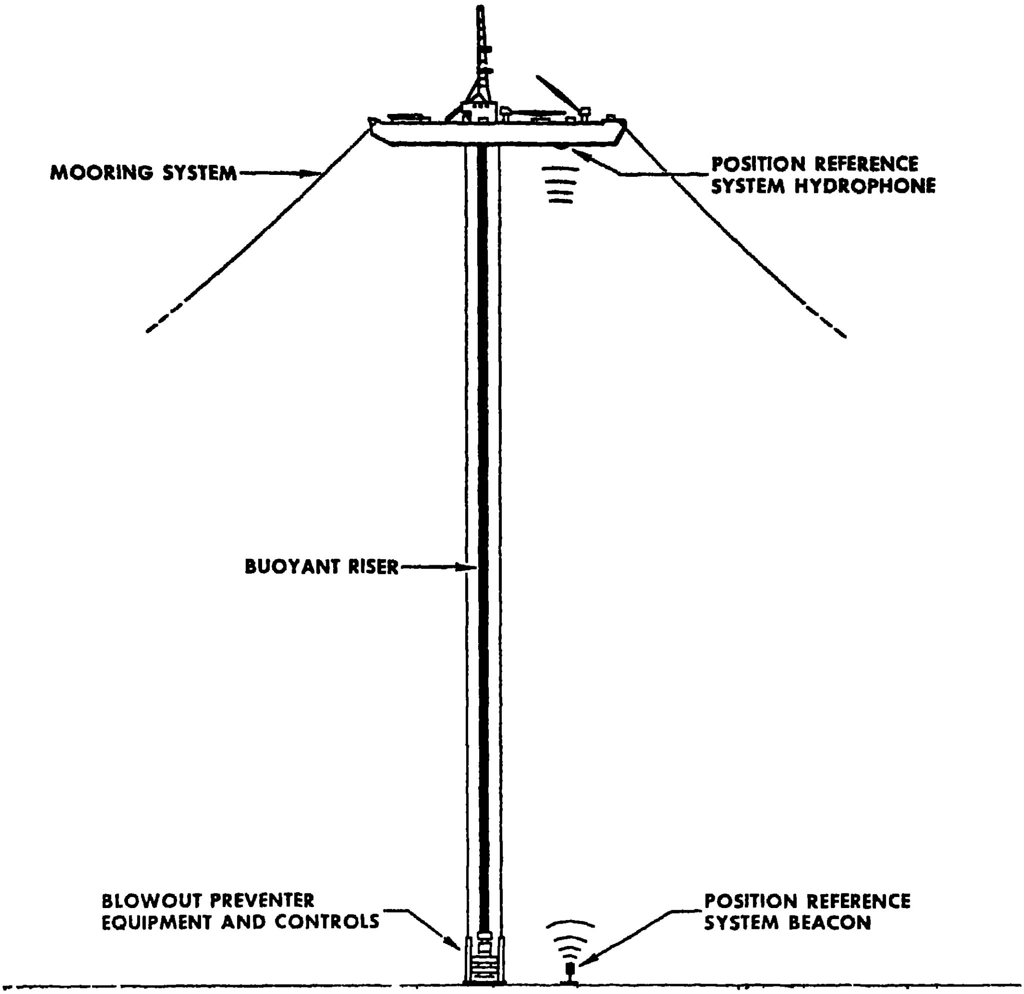


Figure 3.3 Components of a Deepwater Exploratory Drilling System
(From Deepwater Capabilities ESSO Production Research Company.)

The deepest water depth for floating drilling in the Gulf of Mexico was 558 feet during the first half of 1974. However, drilling operations in much greater water depths have been accomplished in other areas, and technology currently exists for deeper operations in the Gulf of Mexico. In the Santa Barbara Channel over 30 wells were drilled and production tested in water depths greater than 500 feet, four of which were in water depths approaching 1500 feet. Shell Oil Company currently is drilling in 2150 feet of water off the coast of Gabon, Africa. This technology is well developed and directly applicable to the Gulf of Mexico.

Exploratory drilling by mobile rigs is regulated and inspected by the USGS and the Coast Guard. The scope of these regulations include personnel safety equipment, rig power system, pollution control procedures, casing setting procedures, mud program, and drilling safety equipment. Failure to comply in any of these items can result in suspension of rig activity until corrections are completed. 1/

1/ Statement of C. C. Taylor, Dept. of Interior Hearings, Louisiana Offshore Annual Sale Number 33, November 28-29, 1973. Edited.

In drilling, two distinct, important pressures must be considered. One is the pressure within the geologic formation penetrated and the other is the pressure required to fracture or allow the drilling fluid to enter the formation below the last casing string and above the drill bit. These pressures are naturally occurring phenomena. A drilling plan calls for maintaining a sufficient hydrostatic gradient to prevent formation fluids from flowing into the wellbore. This is done by adjusting the density or weight of the drilling fluid or "mud" that is continuously circulated through the drill string to provide pressure control, lubrication of the drill bit, and circulation of wellbore cuttings out of the hole (Fig. 4).

In spite of considerable research, it is still not always possible to predetermine, for wildcat wells, the formation pressure and the fracture pressure that the wellbore will encounter. During drilling there are several means of determining the trend in pressure. They include measurements such as formation temperature (as evidenced by the temperature of the returning mud), shale density and changes in the penetration rate of the drill bit.

If the hydrostatic gradient of the drilling fluid becomes less than formation pressure, a "kick" of gas or other fluid may enter the wellbore from the formation being drilled. The influx displaces some drilling fluid, thereby causing reduction in the hydrostatic head in the annular space between the drillpipe and the borehole (Fig. 5).

Example of Well Bore and Casing

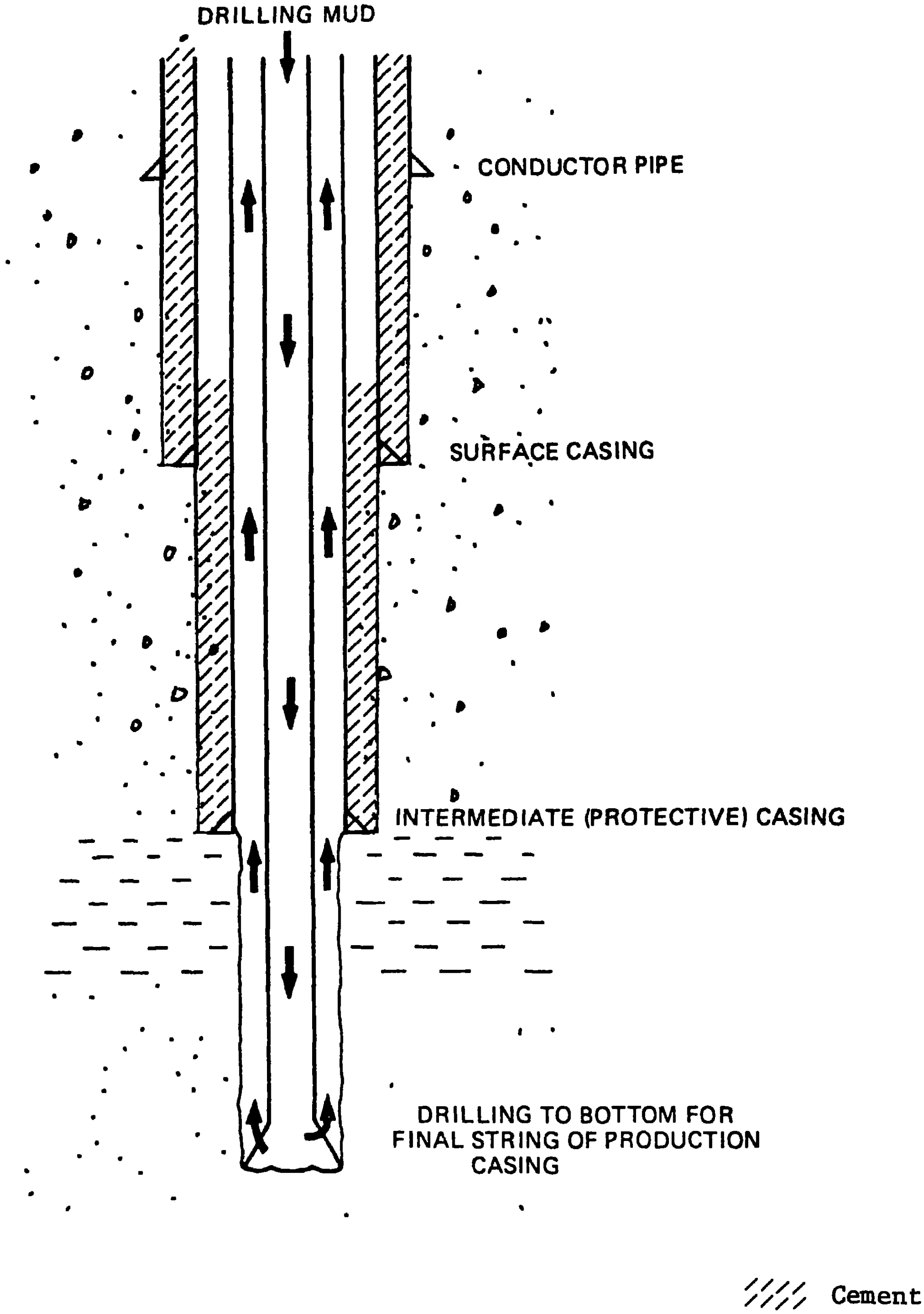


Figure 4.— The drilling mud circulates down through the drill pipe and up the annulus. The relation between the mud pressure gradient and the formation fracture gradient is critical.

(Adapted from Panel on Operational Safety in Offshore Resource Development, "Outer Continental Shelf Resource Development Safety," Marine Board of National Academy of Engineering, Dec., 1972.)

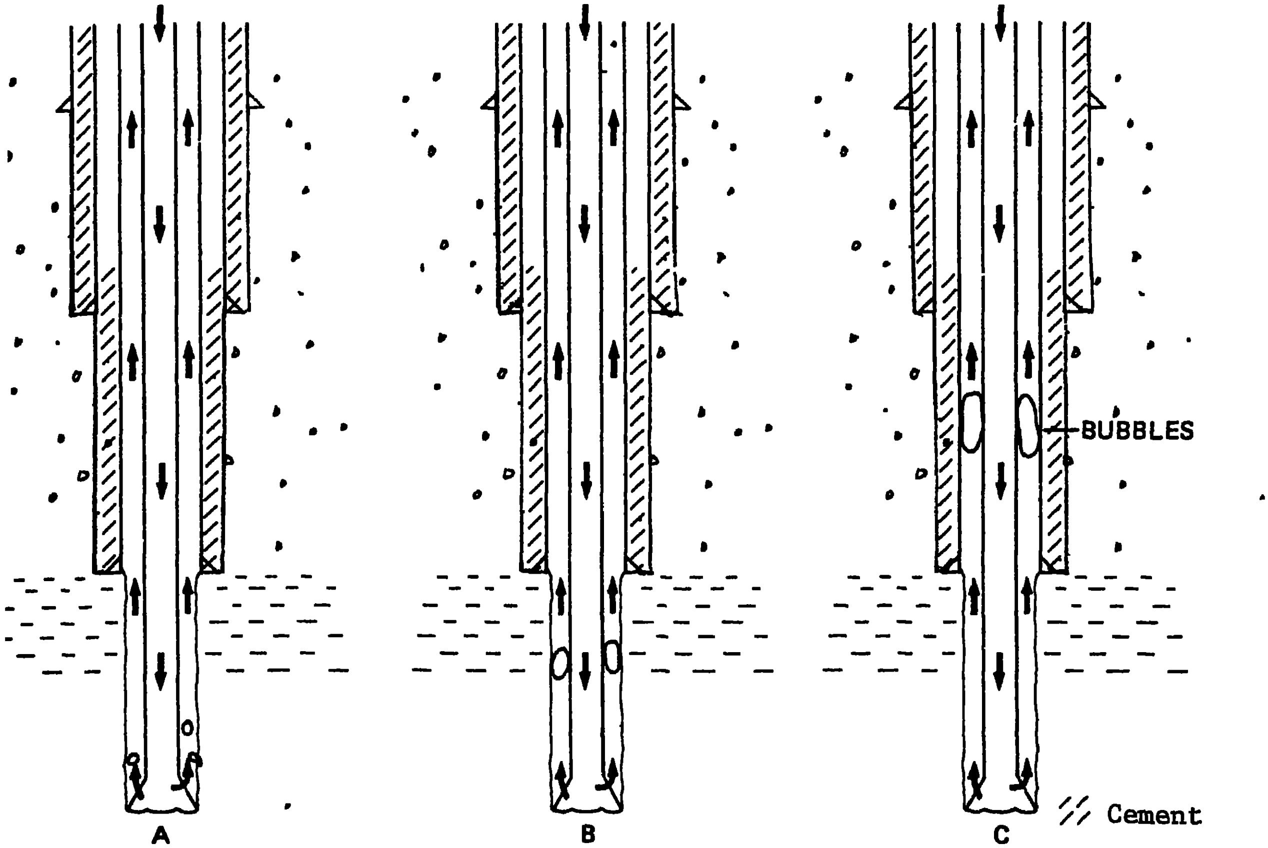


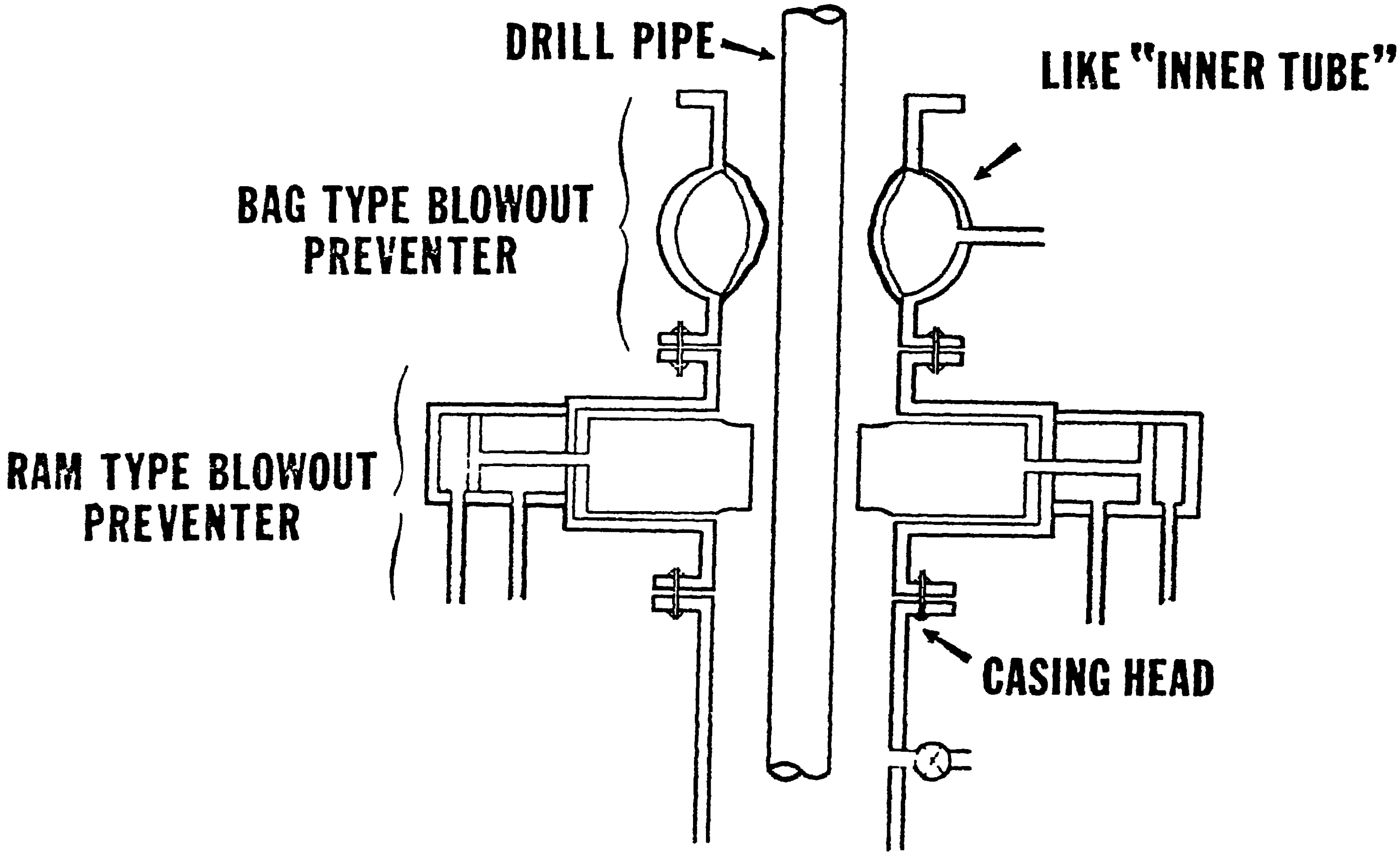
Figure 5.--A "kick" is a gas or liquid influx that reduces the hydrostatic head in the annulus. Here, the kick is a gas bubble (A). As it rises (B and C), it expands--causing a sudden increase in the upflow of the mud. When the bubble reaches the top, if it has not been allowed to expand, the bottom-hole pressure reaches a maximum -- the sum of mud pressure and gas pressure. This pressure maximum, if excessive, can exceed the formation fracture pressure, and lead to a loss of drilling mud to the formation, thus further decreasing the hydrostatic pressure. This could cause an influx of formation fluids into other formations, or the fractured formation taking fluid from another formation, commonly referred to as an underground blow out.

(Adopted from Panel on Operational Safety in Offshore Resource Development, "Outer Continental Shelf Resource Development Safety", Marine Board of National Academy of Engineering, December, 1972).

If the volume of the influx is not excessive, and a surface indication (increased mud tank volume) is observed, the unwanted influx of fluid or gas can be circulated out of the well by careful observation of well conditions and adherence to preplanned emergency procedures. From the record of a kick, the bottom-hole pressure can be determined and with this pressure known, the mud weight can be adjusted to provide the correct hydrostatic head for the safe continuation of drilling.

An uncontrolled kick is called a "blowout". Blowouts seldom occur and usually can be controlled by implementation of preplanned emergency procedures and actuation of devices known as "blowout preventers" which are mounted on every offshore well during drilling. A simplified diagram of a blowout preventer is shown in Fig. 6. Actual blowout preventers used offshore are of at least three types; a bag-type, one with blind rams and one with pipe rams. Blowout preventers are essentially large valves that can close around the drill string or across an open hole and seal off the well at the surface. These valves are so powerful that some are equipped with shear rams that can cut the drill pipe should this procedure aid in controlling the well. The blowout preventer stack can also be mounted on the sea floor and remotely controlled at the drilling console. These seafloor BOP stacks are designed to be used in any water depth and have reaction times of 10 seconds or less. Blowouts can occur downhole when a low-pressure formation fractures, and fluids from a higher-pressure zone flow into the fractured formation. Such underground blowouts, like surface blowouts, require the careful use of preplanned

Figure 6a -- BAG TYPE AND RAM TYPE BLOWOUT PREVENTERS



(From testimony of Bob G. Murphy on behalf of the Offshore Operators Committee at a public hearing in Houston, Texas, on February 22, 1973.)

emergency techniques to regain control. Blowout preventers and other well-control equipment must meet the requirements of OCS Order No. 2. This equipment is tested on a schedule set by prudent practice, but not less often than regulations specify.

To ensure that adequate provisions have been made for safety and well control, the casing program and drilling fluid, or mud, program must be approved by the Geological Survey before a drilling permit is issued. Along with adequate casing, it is important that enough cement be spotted between the casing and the wall of the hole to seal off and isolate all sensitive geological formations such as hydrocarbon zones and freshwater sands, and to separate zones of abnormal pressure from those with normal pressures.

b. Well Completion Phase

Should the initial test be dry, the well is usually plugged and abandoned. Cement plugs are set to confine formation fluids in their parent subsurface formations to prevent them from intermingling and to prevent flow to the surface. During plugging operations, well-control equipment remains in use. When a well is abandoned, the casing is cut-off at least 15 feet below the mud line, all obstructions are removed, and the bottom is dragged to be sure that no obstructions were overlooked. In some cases, it may be necessary to drill several exploratory wells on each block before the lease is totally condemned.

Fluids from formations penetrated by wells are often brought to the surface in drill-stem tests to evaluate the possibility of oil and natural gas production. These fluids are collected in tanks at the surface; drilling mud is separated from the produced fluid, and if the formation fluid is oil it is stored for later disposition; or, the oil and natural gas are flared in specialized, high volume burners.

If well tests show that commercial quantities of natural gas or oil have been found, it may be necessary to do several additional confirmation tests before the company is satisfied that the reserves will support a development drilling and well completion program.

It is also important to delineate as precisely as possible the extent of the petroleum reservoir because of the extreme expense of deeper water platforms and the economic necessity of drilling as many production wells as possible (sometimes over 30) from a single platform. Platform location in relation to hydrocarbon deposits must be extremely accurate to minimize the number of platforms installed.

If petroleum deposits prove to be commercial, one of two courses of action may be followed:

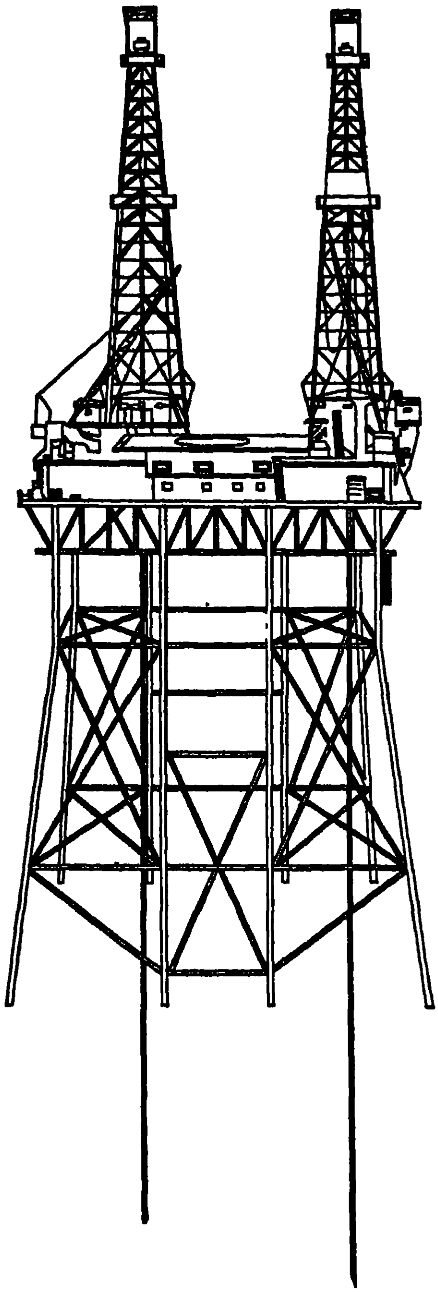
(i) The exploratory well may be deemed expendable and be permanently abandoned. Procedures followed would be the same as above for a dry-hole abandonment.

(ii) The well may be deemed useful as a future production well and temporarily abandoned. In this case, a mechanical bridge plug is placed in the smallest string of casing and the well head capped and left for future entry when production activity commences. This results in the temporary existence of an underwater "stub". The Coast Guard District Commander requires that such stubs be marked by a buoy at the surface if located in 200 feet of water or less, and that the buoy be lighted if located in 85 feet of water or less.

3. Development Drilling, Production and Workover

a. Platform Installation and Production Well Drilling

Offshore drilling and production operations are usually conducted on fixed, bottom-founded, water surface-piercing platforms (Fig. 7). If exploratory efforts are successful in proving a hydrocarbon reserve, production operations are initiated by installing platforms (Fig. 7) to serve as a base for drilling development wells and for subsequent production operations. A number of wells may be directionally drilled to develop a large area from a single platform. Many platforms in the Gulf today contain as many as 20-30 wells.



Rigs mounted on fixed platforms, used for development drilling after an oil or gas discovery, permit drilling up to thirty wells from a single platform and location. After drilling, the rigs are removed, and the platform is used for production.

Figure 7--Fixed Production Platform

(from "The Offshore Search for Oil and Gas," Exxon Background Series No. 2R, Nov., 1972, Public Affairs Dept., Exxon Corp.)

During the 27-year history of oil operations in the Gulf of Mexico, industry has gained a good understanding of the physical forces acting on offshore platforms. Appropriate design procedures are outlined in API Recommended Practice RP 2A and various API specifications. These guidelines have been prepared to cover engineering design and operation of offshore structures and related equipment. USGS OCS Order No. 8 defines regulatory approval procedures for platform design and installation.

Platforms have been installed in the Gulf of Mexico in water depths to 373 feet, and technology exists to extend platform operations to much greater depths. Platforms are now being fabricated for installation in the North Sea in water depths to 500 feet. A design for installation in 850 feet of water at the Santa Ynez Unit in the Santa Barbara Channel has been completed and is ready for implementation and a design for a 1020 foot platform for the Gulf of Mexico is underway.

The major difference between current operations and deep water platform installations will be the offshore erection techniques. In typical Gulf of Mexico template type structures, the lower portion, or jacket, is barged to sea, launched, upended and secured to the sea floor with piling driven through the legs. The deck section is then lifted into place and secured by welding.

Because of the large size of a platform for 800-1200 feet of water, the lower portion could be fabricated onshore and barged to sea in two or more sections. At least two methods have been devised and determined to be practical using current construction equipment for fabricating and installing multi-section structures. The proposed 850-ft. water depth platform designed for Santa Barbara Channel will have two sections joined at sea in a horizontal position. Then the structure will be upended by controlled flooding, set on bottom and secured with piling. The deck section will be set in place in a conventional manner.

In a second method, being developed for the Gulf of Mexico, the lower jacket portion will be built in three sections. The base section will be launched as in figure 8-1 and placed on bottom with derrick barges as shown in figure 8-2, then secured with piling. The upper two sections of the jacket will then be set successively in place atop the base as in figure 8-3 and 4. All three sections will be joined by cementing a large tubular member inside each of the platform legs. Finally the deck section will be installed in a conventional manner as shown in figure 8-5. 1/

1/ The preceding three paragraphs were taken from testimony presented by Offshore Operators Committee at Hearing on Proposed Louisiana Oil and Gas Lease Sale #36. New Orleans, Louisiana, June 5, 1974.

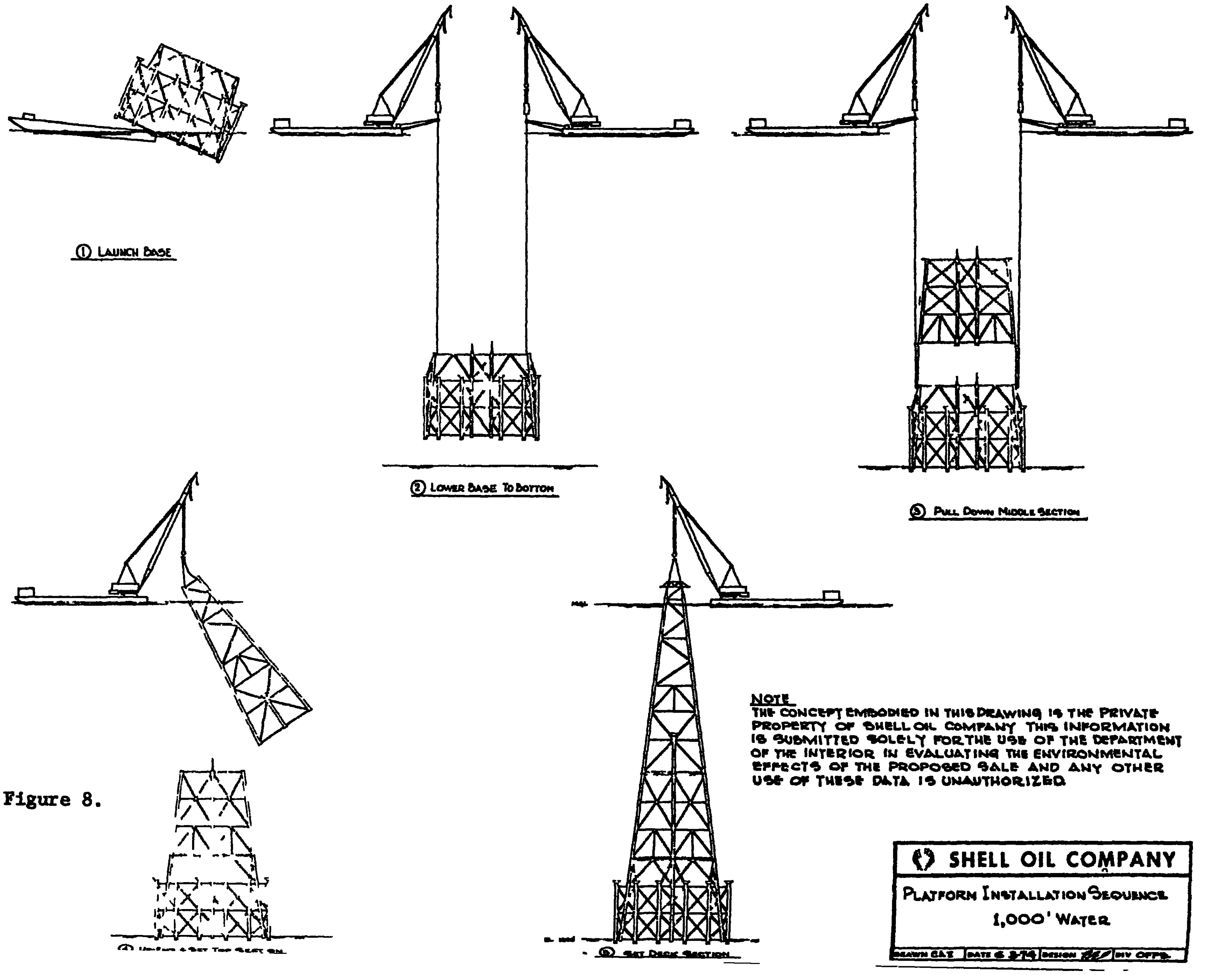

① LAUNCH BASE
② LOWER BASE TO BOTTOM
③ PULL DOWN MIDDLE SECTION
⑤ SET DECK SECTION
NOTE
THE CONCEPT EMBODIED IN THIS DRAWING IS THE PRIVATE PROPERTY OF SHELL OIL COMPANY THIS INFORMATION IS SUBMITTED SOLELY FOR THE USE OF THE DEPARTMENT OF THE INTERIOR IN EVALUATING THE ENVIRONMENTAL EFFECTS OF THE PROPOSED SALE AND ANY OTHER USE OF THESE DATA IS UNAUTHORIZED
SHELL OIL COMPANY
PLATFORM INSTALLATION SEQUENCE
1,000' WATER
DRAWN
DATE
DESIGN
DIV OFFS.

Figure 8.

More than 87% of the 295 tracts proposed for lease in this sale should be able to be developed in the conventional manner.

Buoyant towers have potential applications in water depths greater than about 1000 feet. These towers are pivoted at the base and are stabilized in a vertical position by buoyant chambers. Unlike conventional platforms, buoyant towers sway under the action of wave forces instead of resisting them. In waters much less than 1000 feet deep, however, the sway of these towers would be excessive. Towers that would support two drilling rigs, production equipment, and 40 to 60 wells appear feasible for water depths between 1000 and 2000 feet. One concept of such a tower is shown in Figure 9. This type drilling platform has never been used on the U.S. OCS.

Another concept--the "tension leg platform"--is nearing the model testing stage. This platform will be tethered to the bottom by cables attached to anchors, deadweights or grouted pilings on the sea floor. Just below the water surface is a buoyant section designed to maintain constant tension in the legs and support the working platform and its load above the water surface. The net effect is supposed to be a "tower" that will provide a stable working surface without presenting a rigid, inflexible structure against the forces of the sea. A one-third scale model (100x100 foot platform) is scheduled to be tested in 250 feet

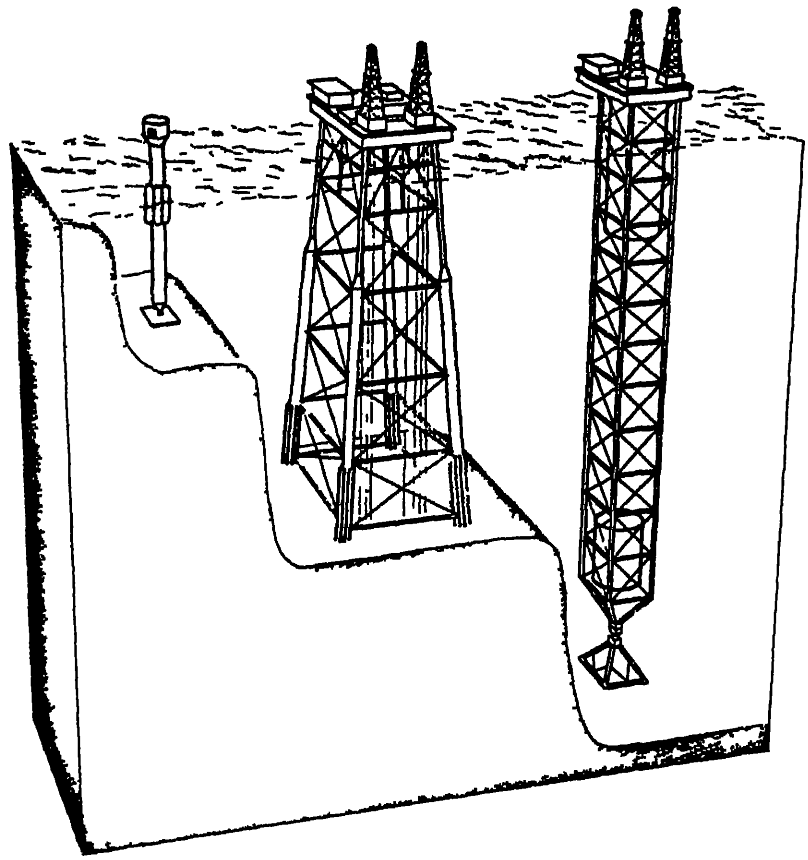


Figure 9. French test of buoyant tower in 325 feet of water, compared with Esso concept of 700-foot platform and 1350-foot tower.

(from Deepwater Capabilities Esso Production Research Company.)

of water near Catalina Island next year (1975). If the concept proves feasible, this "tension leg platform" would be used in water depths deeper than 600 feet. Maximum depth for this type platform has not been determined but it is expected to be in excess of 3000 feet.

The drilling rig, power plants, generators, living quarters, storage sheds and other components, constructed in modular form, are added to the platform, and production well drilling commences. Equipment anticipated for use on deep water platforms is similar to that being used safely in current shallow water operations, and will be installed and operated in accordance with safe practices accumulated from industry experience. These practices form the basis of USGS OCS Order No. 8, which gives the safe practices a regulatory mandate. This order specifies multiple, redundant controls and safety devices including safety shut-in valves, high-low pressure pilots, high-low level controls, high-temperature shutdowns, gas detectors, shielded ignitions, fire prevention and detection equipment, and pressure relief systems. Drain and sump systems are also designed to collect any spillage that might occur on the platform. The sequence of drilling operations for production wells is essentially the same as for exploratory wells.

As water depths increase, the economic desirability of seafloor completions and, in fact, an entire subsea production system increases. Considerable progress has been made in this direction.

The basic component of a subsea system is an individual subsea well drilled with a mobile rig. 1/ The wellhead is located on the seafloor, and flowlines and control lines connect to a nearby platform. The wellhead valves are remotely operated from the platform and are designed to close automatically if required. Well maintenance can be performed by pumping tools through the flowline, or by wireline operations from a floating rig. Reliability and safety of these systems has been field proven on 89 subsea completions since 1962. Of these, 44 are in the Gulf of Mexico and 19 are off the California coast. Water depth ranges from 35 to 375 feet.

One type of subsea well uses "wet" trees which are exposed to the seawater. The "wet" tree equipment is relatively insensitive to water depth, and can be installed in deep water in the same manner as in shallow water. A "wet" tree which had been in service for over seven years was retrieved recently and found to be in excellent condition. Another more recently developed system is the "dry" system. Wellhead equipment is essentially the same as

---

1/ This discussion extracted from testimony presented by Offshore Operators Committee at Hearing on Proposed Louisiana Oil and Gas Lease Sale #36. New Orleans, Louisiana, June 5, 1974.

in a "wet" system, except it is housed in a dry, atmospheric chamber on the sea floor. Flowline connection and maintenance work can be performed by workmen inside the chamber, in a normal atmospheric, shirt-sleeve environment. The workmen are transported to and from the chamber in a tethered, atmospheric diving bell which mates to the chamber, allowing completely dry access for nondivers. One such completion was made in the Gulf in 1972 in 375 feet of water and has been on production since. The chamber was reentered successfully last year (1973) for routine inspection and maintenance, and found to be in excellent condition. To date, most subsea wells have been equipped with velocity actuated subsurface safety valves. The velocity type can be pumped into place and retrieved through the flowline. Industry has recently developed surface controlled subsurface safety valves which may be pumped through the flowline. They are undergoing field testing at this time.

There are at least three subsea production systems currently under development which are designed to serve multiple wells. These systems will provide gathering, measurement and control of well streams and enable through the flowline (TFL) well maintenance. One system is the Lockheed system which is being jointly developed by Shell and Lockheed with support from 11 other offshore operators. Fabrication work on the manifold center is nearing

completion, and offshore installation in 240 feet of water is scheduled for 1975.

An encapsulated system was built by Subsea Equipment Associates, Ltd. (SEAL) and was tested in the Gulf of Mexico in 250 feet of water during the past two years. It provides a template for multiple wells connected to an atmospheric manifold center.

A different system concept is Exxon's SPS system. It has been developed and tested extensively in a pit over the past five years, and is scheduled for installation in the Gulf this summer. This system provides for a number of subsea wells clustered on an underwater template with associated manifolding and processing equipment. This can be serviced by a remote manipulator.

All three of the above systems are undergoing shallow water tests to demonstrate their capabilities to perform their intended functions reliably. In each system, the design concepts are applicable to operations in at least 2000 feet of water.

Remote mechanical and hydraulic connectors will be used to attach the flowline to the underwater wellhead. Technology to perform this is currently being developed and is to be tried and perfected in shallower water, with test programs scheduled for this summer. As the techniques are developed and tested, they can then be extended into deeper water operations.

Subsea completions will result in sea floor obstructions that could foul trawling gear; however, only a small portion of the total trawling effort takes place at depths where subsea completions are most likely to be used. Should a trawl snag a subsea completion the possibility that it would damage any of the wellhead assembly to the extent of causing uncontrolled flow is extremely remote because of the strength and durability of the material that would be used in the sea floor structure.

Wells usually are produced through tubing placed inside the final or production string of casing. During tubing installation, the blowout preventers remain in use to ensure control of the well. A system of in-tubing safety valves, plus other casing and tubing valves at the surface or sea floor, is installed to control well flow. Actuation is usually at the producing platform. A wellhead, consisting of several redundant control valves, is installed at the platform lower deck level and subsurface safety valves are installed at depths varying from a few hundred to several thousand feet in the tubing string.

Of major concern in the operation and control of every production platform are the downhole control devices. Production tubing is fitted with one or more safety valves that are installed and located at least 100 feet below the mud line or sea floor. In the past, velocity choke valves ("storm chokes") designed to shut-off

production when the flow rate exceeds predetermined limits have been used. Such valves should close if surface equipment failure results in an excessive flow through the tubing. These chokes are particularly susceptible to failure from internal erosion in areas where sand is produced along with the oil and gas.

Certain types of subsurface fail-safe valves do not depend on the velocity of well fluids for actuation, but are held open by hydraulic or other fluid pressure applied from the surface. The valve is designed to close automatically, shutting off the flow of fluid from the well in the event of some undesirable situation of the platform. Essentially all wells drilled since December 1, 1972, are equipped with valves that are actuated from the surface. These valves provide highly reliable protection and may be tested frequently to insure proper operation. Their use will increase costs significantly, but the need for more reliable valves has been shown by recent incidents in the Gulf of Mexico and elsewhere. The increased degree of safety offered by use of the fail-safe valves should justify their installation.

Blowout preventers as well as downhole control devices have proven to be extremely valuable, in time of accidents and emergencies, in preventing large amounts of oil from escaping into the environment. When hurricanes have passed through offshore oil and gas fields, entire platforms have been swept away with only a minimal spillage of oil (see section II.B.6.b.).

Blowout preventers on drilling wells and the redundant combination of wellhead valves and subsurface safety valves have proven effective in maintaining control of wells when the normal controlling devices (drilling mud and production regulators and chokes) have failed. Once shut-in, the wells can be reentered through either the blowout preventers or wellhead valve with drill-pipe or tubing to perform remedial work and bring the well back under control. This can be done if the blowout preventer or wellhead is on the sea floor the same as if they were located on a platform. Likewise, should a well get completely out of control and crater around and outside the surface casing so that the well could not be reentered, then an offset relief would have to be drilled. The availability of a deep water rig to drill a relief well would depend upon the number of deep water tracts leased and being explored or developed simultaneously.

b. Disposal of Drill Cuttings and Drilling Mud

As with exploratory drilling, the casing and mud programs for each development well must be approved by the Geological Survey before a drilling permit is issued.

The following information was furnished by the Geological Survey and the petroleum industry and pertains to the drill cuttings and drilling mud discharges from a typical offshore well which is assumed to be:

1) a development well (not exploratory)

2) drilled from a multi-well slot platform using a standard platform mounted rig

3) a "normal" well, i.e. one in which no special drilling problems or mud problems are experienced which would cause an abnormal volume of cuttings or usage of mud

4) drilled to a total depth of 10,000 feet.

This typical 10,000-foot offshore well generates almost 1,700 barrels of cuttings weighing about 700 tons. To drill this well seawater drilling mud containing almost 300 tons of mud components are used. The total weight of cuttings and mud components discharged overboard is some 600 to 900 tons per well. (Whole mud is, on occasion, treated and used as packer fluid in the well--thus all surplus mud is not dumped overboard.) Average drilling time is 10 to 14 days; therefore, the amount of drill cuttings and drilling mud components discharged into the Gulf of Mexico must average about 90 tons per day per <u>drilling</u> well. All discharge must, of course, comply with OCS Order No. 7 (Attachment A).

The casing program for this well consists of four strings:

1) the structural casing, (drive pipe) is usually 30 inches in diameter. It is set to a minimum depth of 100 feet to provide stability in unconsolidated sediments
2) the 16-inch conductor pipe, set at 900 feet
3) the 10 3/4-inch surface casing, set at 3,500 feet
4) the 7-inch production string, set at 10,000 feet.

Table 1 shows the volume of cuttings generated by the typical 10,000 foot well.

Table 1. Volume of Drill Cuttings Generated in Typical 10,000 Foot Offshore Well

Interval (feet)	Hole Size (inches)	Volume of Cuttings (barrels)	Weight of Cuttings (pounds)
0-900	24	503	407,000
900-3500	15	569	460,000
3500-10,000	9 7/8	615	497,000
Total		1,687	1,364,000

As the drilling fluid-drill cuttings mixture is circulated to the surface, drill cuttings are separated from the drilling fluid by shale shakers, desilters, and desanders, and discharged overboard.

Approximately 7,000 barrels of seawater plus commercial mud components comprise the drilling mud used to drill this typical offshore well. Almost 300 long tons of commercial mud components are used to make up and maintain the drilling muds in the well. Conditioning of the mud system in order to maintain the desired mud characteristics requires some overboard discharge of clay solids in the mud and an addition of commercial mud and seawater to the system daily. Table 2 shows typical quantities of commercial mud components used to drill a well to 15,000 feet on the OCS. The intervals between usual casing points is used so some rough interpolations can be made. The top 900 foot section of the well is drilled with a mixture of seawater commercial mud components (barium sulfate, clays and caustic) and the natural mud and clays from the surface formations that are drilled. Shale particles and sand are discharged overboard as this section of the hole is drilled.

Prior to installation of the 16 inch conductor pipe in the hole, a gelled seawater mud is mixed and circulated into the well bore, and the natural mud system is discharged overboard after first recovering most of the barium sulfate. This gelled seawater mud

Table 2. Mud Components used in seawater - Lignosulfonate Systems to 15,000 feet. Weight in pounds 1/

Component	Interval 0-900 Feet	Interval 900-3500 Feet	Sub-total 3500 Feet	Interval 3500-10,000 Feet	Sub-total 10,000 Feet	Interval 10-15,000 Feet	Total 15,000 Feet
Barium Sulfate (Barite)	3,000	3,000	6,000	529,000	535,000	625,000	1,160,000
Bentonitic Clay	10,000	10,000	20,000	36,000	56,000	9,000	65,000
Attapulgite Clay	5,000	5,000	10,000	-	10,000	-	10,000
Caustic	500	500	1,000	20,000	21,000	23,000	44,000
Aromatic Detergent		1,000	1,000	2,000	3,000	-	3,000
Organic Polymers		1,000	1,000	3,000	4,000	-	4,000
Ferrochrome Lignosulfonate				26,000	26,000	69,000	95,000
Sodium Chromate						2,000	2,000
Totals	18,500	20,500	39,000	616,000	655,000	728,000	1,383,000

1/ It is emphasized that these are "typical" values and quantities may vary by as much as 50% from well to well.

As the drilling fluid-drill cuttings mixture is circulated to the surface, drill cuttings are separated from the drilling fluid by shale shakers, desilters, and desanders, and discharged overboard.

Approximately 7,000 barrels of seawater plus commercial mud components comprise the drilling mud used to drill this typical offshore well. Almost 300 long tons of commercial mud components are used to make up and maintain the drilling muds in the well. Conditioning of the mud system in order to maintain the desired mud characteristics requires some overboard discharge of clay solids in the mud and an addition of commercial mud and seawater to the system daily. Table 2 shows typical quantities of commercial mud components used to drill a well to 15,000 feet on the OCS. The intervals between usual casing points is used so some rough interpolations can be made. The top 900 foot section of the well is drilled with a mixture of seawater commercial mud components (barium sulfate, clays and caustic) and the natural mud and clays from the surface formations that are drilled. Shale particles and sand are discharged overboard as this section of the hole is drilled.

Prior to installation of the 16 inch conductor pipe in the hole, a gelled seawater mud is mixed and circulated into the well bore, and the natural mud system is discharged overboard after first recovering most of the barium sulfate. This gelled seawater mud

Table 2. Mud Components used in seawater - Lignosulfonate Systems to 15,000 feet. Weight in pounds 1/

Component	Interval 0-900 Feet	Interval 900-3500 Feet	Sub-total 3500 Feet	Interval 3500-10,000 Feet	Sub-total 10,000 Feet	Interval 10-15,000 Feet	Total 15,000 Feet
Barium Sulfate (Barite)	3,000	3,000	6,000	529,000	535,000	625,000	1,160,000
Bentonitic Clay	10,000	10,000	20,000	36,000	56,000	9,000	65,000
Attapulgite Clay	5,000	5,000	10,000	-	10,000	-	10,000
Caustic	500	500	1,000	20,000	21,000	23,000	44,000
Aromatic Detergent		1,000	1,000	2,000	3,000	-	3,000
Organic Polymers		1,000	1,000	3,000	4,000	-	4,000
Ferrochrome Lignosulfonate				26,000	26,000	69,000	95,000
Sodium Chromate						2,000	2,000
Totals	18,500	20,500	39,000	616,000	655,000	728,000	1,383,000

1/ It is emphasized that these are "typical" values and quantities may vary by as much as 50% from well to well.

is used to drill the next 2,600 feet of hole. Table 2 shows the weight and various components used to make up and maintain the required characteristics of the mud while this interval is drilled. A total volume of 700 barrels is made up and maintained in the system.

Before drilling out of the 10 3/4-inch casing, the gelled seawater mud is converted to a ferrochrome lignosulfonate mud for drilling the final section of the hole. The conversion is effected by adding seawater, ferrochrome lignosulfonate and other materials. This conversion may be done deeper in the hole, depending on the geologic formations being drilled.

When drilling is resumed after the conversion, the mud system volume is expanded to 950 bbl., in order to allow for deepening of the hole. Table 2 also shows the weight of ferrochrome lignosulfonate mud while drilling the final 5,500 feet of hole. After the 7-inch production string of casing is set, the mud in the tanks is saved for use in drilling the next well. After the final well is drilled, the barite is usually barged ashore for recvoery of chemical components or storage. Occasionally, when transport to shore storage facilities is not feasible, the unweighted components (whole mud less barite) are discharged overboard. In the case of a dry hole, the drilling mud is often left in the abandoned hole. In producing wells, drilling mud is often used to fill the annular space between tubing and casing

above the packer. Barite is barium sulfate ($BaSO_4$) with a sp. gr. of 4.5 and solubility of less than 0.0004 grams per 100 ml. of water; thus any of this material not removed by certifuging and dumped overboard would sink very rapidly and would dissolve very slowly. The commercial value (cost) of the barite will tend to keep any dumping to a minimum. Chromium is known to be toxic, either as an element or in low concentration of various compounds.

Ferrochrome lignosulfonate has been shown to be toxic to freshwater fish in concentration greater than 1000 ppm (LC50 at 96 hours) 1/. According to a biologist from "MAGCOBAR", a mud supply company (personal communitication), the toxicity is apparently due to a toxic iron (not chromium) compound that forms in an acid environment. However, Baroid Division of NL Industries, another mud supply company, states there is no documentation to support that the toxicity is attributed to iron rather than chromium. "MAGCOBAR" also stated (personal communication) that the mud supply companies are switching to a chromium lignosulfonate component which has no iron, performs just as well, and shows no harm to fish after 96 hours at concentrations greater than 10,000 ppm. Again, Baroid refuted this statement in their testimony at the

1/ Falk, M. R. and M. J. Lawrence. 1973. Acute toxicity of petro-chemical drilling fluids components and wastes to fish. Tech. Rept. Series No. CEN-T-73-1. Resource Mgmt. Branch, Dept. of Environment, Freshwater Inst., Winnipeg, Manitoba.

public hearing in New Orleans, June 5, 1974. Sodium chromate is a potentially toxic material which is occasionally (not always) used on deeper completions, and then only in relatively small amounts. See Sec. IV.A.5-6. for additional discussion of chromium.

Special Cases

Occasionally, abnormal formation pressures, exceptionally tight formation, or other problems require the use of oil-based or highly treated drilling muds. Drill cuttings are then separated and cleaned of entrained oil before being discharged overboard, and the drilling muds are retained and shipped to shore and stored in tanks for future use.

c. Produced Formation Water

The waters associated with oil and gas pools which are frequently produced along with the oil and gas are called formation waters. The lower edge or boundary of most oil and gas pools is marked by oil-water or gas-water contact. In some pools, water is produced with the oil in early stages of production, whereas in others, appreciable water is never produced with the oil.

Most formation waters produced in the Gulf of Mexico are brines, characterized by an abundance of chlorides, mostly as sodium chloride and have concentrations of dissolved solids several times

greater than that of seawater. The total amount of mineral matter commonly found dissolved in oil-field waters ranges from a few milligrams per liter (mg/l), nearly freshwater, to approximately 300,000 mg/l, a heavy brine.

The following table (Table 3) shows the content of three representative brines: (1) high solids, (2) average solids, and (3) low solids. The average total dissolved solids of 76 samples from southern Louisiana and the Outer Continental Shelf was found to be 112,513 mg/l with a high of 270,400 mg/l and low of 61,552 mg/l. Note that they commonly contain varying amounts of iron, calcium, magnesium, sodium, bicarbonates, sulphate, and chloride, with sodium and chloride being the most abundant ions.

Total formation water production from all OCS operations offshore Louisiana is about 603,000 barrels per day; 305,000 barrels per day are transported to shore for treatment and release, and the remaining 298,000 barrels per day are treated and discharged near the platforms.

It is highly unlikely that any of the produced formation water resulting from this sale would ever be piped ashore. Both economic and environmental considerations weigh heavily towards choosing to treat and release the water into the ocean at the platform site or reinject it into subsurface formations. Reinjection is utilized where feasible as a secondary recovery technique by

Table 3. Chemical Content of Representative Offshore Brines 1/

Component	High Solids		Average Solids		Low Solids	
	Mg/1	%	Mg/1	%	Mg/1	%
Iron	153	0.057	15	0.011	139	0.226
Calcium	17,000	6.287	4,675	3.294	772	1.254
Magnesium	2,090	0.773	1,030	0.726	152	0.247
Sodium	84,500	31.250	49,120	34.612	22,651	36.800
Bicarbonate	37	0.014	100	0.070	933	1.516
Sulphate	120	0.044	0		188	0.305
Chloride	166,500	61.575	86,975	61.287	36,717	59.652
Total Solids	270,400	100%	141,915	100%	61,552	100%

1/ From U.S. Geological Survey, Oil and Gas Supervisor, Gulf of Mexico Area New Orleans, Louisiana.

pumping formation water, under pressure, back into the lower levels of the petroleum-producing zone and thus maintaining good reservoir pressure. Disposal of formation water into other than the producing formation is not done because of the expense involved. This method of disposal requires a separate well plus some water treatment to insure that the injected water is compatible with the host reservoir. Formation water which is to be discharged into the ocean is first passed through a water-treating facility that removes all but traces (maximum permissible average = 50 ppm) of entrained oil. However, the water is still void of dissolved oxygen and contains large quantities of dissolved minerals.

d. Solid Waste Disposal

All solid waste accumulating from daily drilling and production operations is collected in large containers constructed of heavy grating. To reduce the bulk before being transferred to shore, wastes are sometimes compacted in mechanical compactors but are generally incinerated in burn baskets suspended from the platform. Ashes are allowed to fall into the water. Non-combustible solids are then loaded into service boats for transfer to shore. Solid wastes, transferred to shore, are emptied into municipal or private sanitary landfills which are subject to the sanitary landfill laws of the State.

Sewage treatment and disposal on offshore rigs and platforms is very similar to the common septic tank, but with the addition of a chlorination system. In this case the septic tank is normally a fiberglass container somewhere on the platform into which all toilet, kitchen, and laundry drains discharge. The usual settling and bacterial digestion takes place in this tank and the final effluent is chlorinated. OCS Order No. 8 requires that the effluent shall contain 50 ppm or less of biochemical oxygen demand (BOD), 150 ppm or less of suspended solids, and shall have a minimum chloride residual of 1.0 mg/l after a minimum retention time of fifteen minutes.

e. Workover Operations

Since petroleum production involves the handling of flammable fluids under pressure, the safety systems control is of utmost importance to preclude hazardous conditions. Nowhere is this hazard greater than during workover, or remedial operations on a well in order to improve its production rate or to replace faulty downhole equipment. Since workover operations are potentially hazardous, they must be planned carefully, both to keep wells from getting out of control and to prevent or minimize the release of oil to the environment. Currently under review within Geological Survey is a proposal to revise OCS Operating Order No. 8 to reduce or prohibit simultaneous production and drilling from the same platform. The restrictions will apply to workover operations as well as to drilling and production operations.

To reduce pollution, specially treated salt water that can be weighted with various materials is used for hydrostatic control when re-entering the wells in wire-line or swabbing operations.

To increase production, acid or other fluids and suspended particulate matter may be pumped through the well bore into producing formations. The function of this treatment is to enlarge flow channels leading to the well. The spent acid returns up the well when production is resumed, and is handled as are other fluids from the well. Oil and water contaminated with acid are transported with the rest of the production to the refinery.

Sand produced along with the well fluids can cause the wells to plug, or "sand-up", periodically and must be removed. Other procedures to increase productivity and oil recovery include the injection of high-pressure steam, water and/or gas into specially prepared injection wells. The water used for this purpose may be taken from the ocean or from formation water. Water too contaminated to be treated, and discharged is reinjected into formations, taking suitable precautions to ensure that fresh water acquifers will not be contaminated by oil or salt water. Gas produced from the well may be reinjected for pressure maintenance where feasible or piped to shore for sale.

From the safety standpoint, completion and workover operations must be conducted carefully, and it is their critical nature that, in

all likelihood, makes these operations safer than they otherwise might be. Operators of swabbing and wire-line units are well aware of the hazardous nature of their work and are extremely cautious. Despite the potential hazard, safety records during wire-line and swabbing unit work are excellent.

4. Transportation of Produced Oil and Gas

Since all of the proposed tracts which are expected to produce oil are near to presently producing areas, it is highly unlikely that any form of transportation other than pipeline will be used to move the produced oil and gas to the mainland.

Nearly all hydrocarbons produced on the OCS are transported by pipeline (as of 1971, only 3 1/2% of OCS crude oil was transported by barge). All natural gas, of course, must be moved by pipeline. A substantial amount of natural gas is necessary to justify economically the construction of a natural gas pipeline. In the early stages of the development of an oil field, small amounts of gas may be vented or flared or reinjected into the petroleum reservoir to maintain good pressure. However, wasteful venting or flaring is prohibited by OCS Order No. 11.

a. Construction and Burial

Pipelines laid offshore are constructed and laid by several different methods, depending mainly on the size, location, intended use, and cost. One method, pipepulling, involves the use

of barges and tugs to pull sections of welded pipe from an onshore launchway over the preselected right-of-way. These sections may either be dragged along the bottom or suspended by floats. There are at least three limitations to this system. First, an extensive section of shoreline, roughly perpendicular to the shore, must be available for the fabrication and launchway site. (Alternatively, it is possible although more costly to use a launching jetty constructed from the beach out over the water.) Second, the total length of pipeline that can be laid is limited. One company estimates the limit to be 100,000 feet for smaller diameter pipe. Third, the pipeline right-of-way must be essentially a straight line. The pipe pulling method is not used often for laying pipelines to OCS locations.

Offshore pipelines, particularly large diameter or long line, are usually installed using a barge specially constructed for marine 1/ pipelining called a "lay barge". This barge is a self-contained unit including all of the facilities required to join the pipe by welding, cover the weld with protective coating, and to lower the pipe into place on the ocean floor. The pipe is coated on shore and delivered to the lay barge in uniform lengths or "joints" with the ends prepared for welding. Several anchors, at least two at

---

1/ This discussion extracted from testimony presented by Offshore Operators Committee at Hearing on Proposed Louisiana Oil and Gas Lease Sale #36, New Orleans, Louisiana, June 5, 1974.

each corner, are used to hold the barge in position. Joints of pipe are welded together on the deck of the lay barge to form a continuous length. When a weld is finished, inspected and coated, the barge is moved forward allowing the assembled pipeline to extend over the stern of the barge and to sag downward to lay on the ocean floor. A new length of pipe is added to the "forward" end of the pipeline and the process is repeated. The attached Figure 10 shows a typical lay barge illustrating the location of the welding, coating and X-ray stations.

Making a high-quality pipeline weld requires a reasonable amount of time. Therefore to obtain rapid production, "assembly line" techniques are used allowing welding to take place at several stations simultaneously. To do this the work on the barge must take place in an almost level position. From the barge to the ocean floor the pipe will assume a double curve or "S" shape. If the pipe is too heavy or too stiff to reach the bottom unsupported, a buoyant pontoon or slide called a "Stinger" is used to provide support for the upper section of the pipeline. Figure 11 shows a typical arrangement of the pipeline and supporting member or stinger. To help support the weight of the pipe and to prevent buckling, a carefully controlled tension force is applied to the pipe by constant tension machines mounted on the barge.

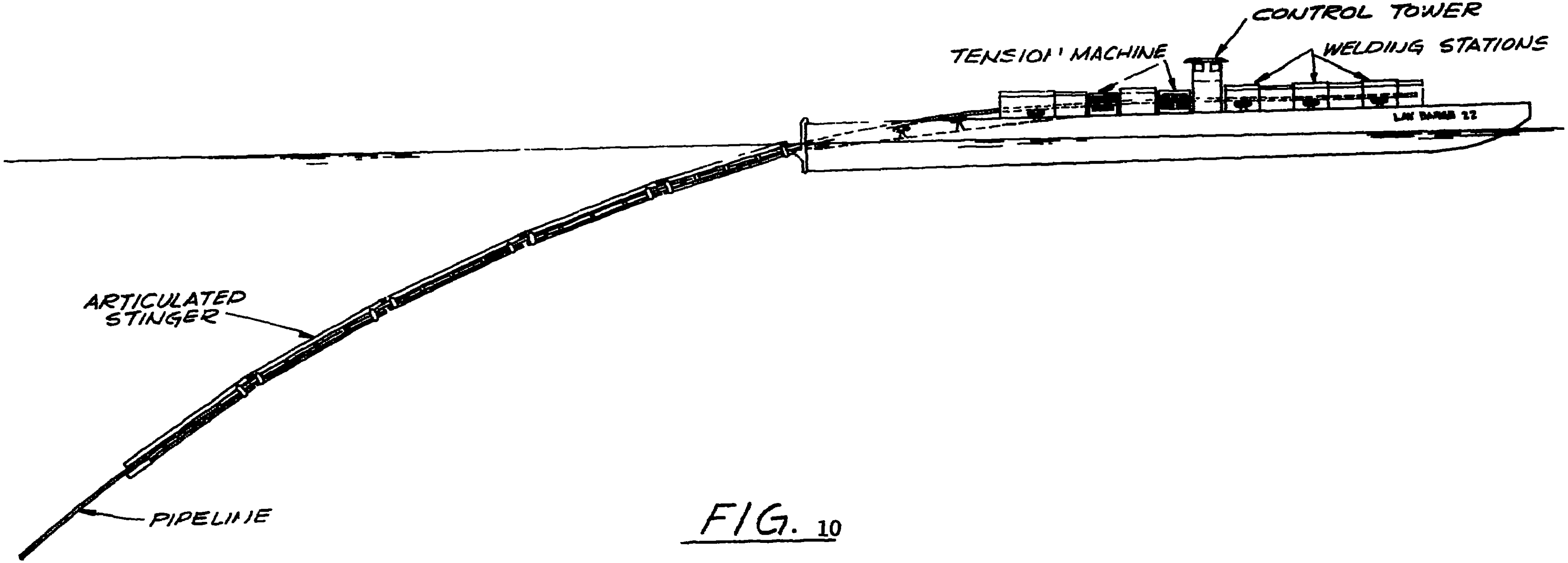

CONTROL TOWER
TENSION MACHINE
WELDING STATIONS
ARTICULATED STINGER
PIPELINE

FIG. 10

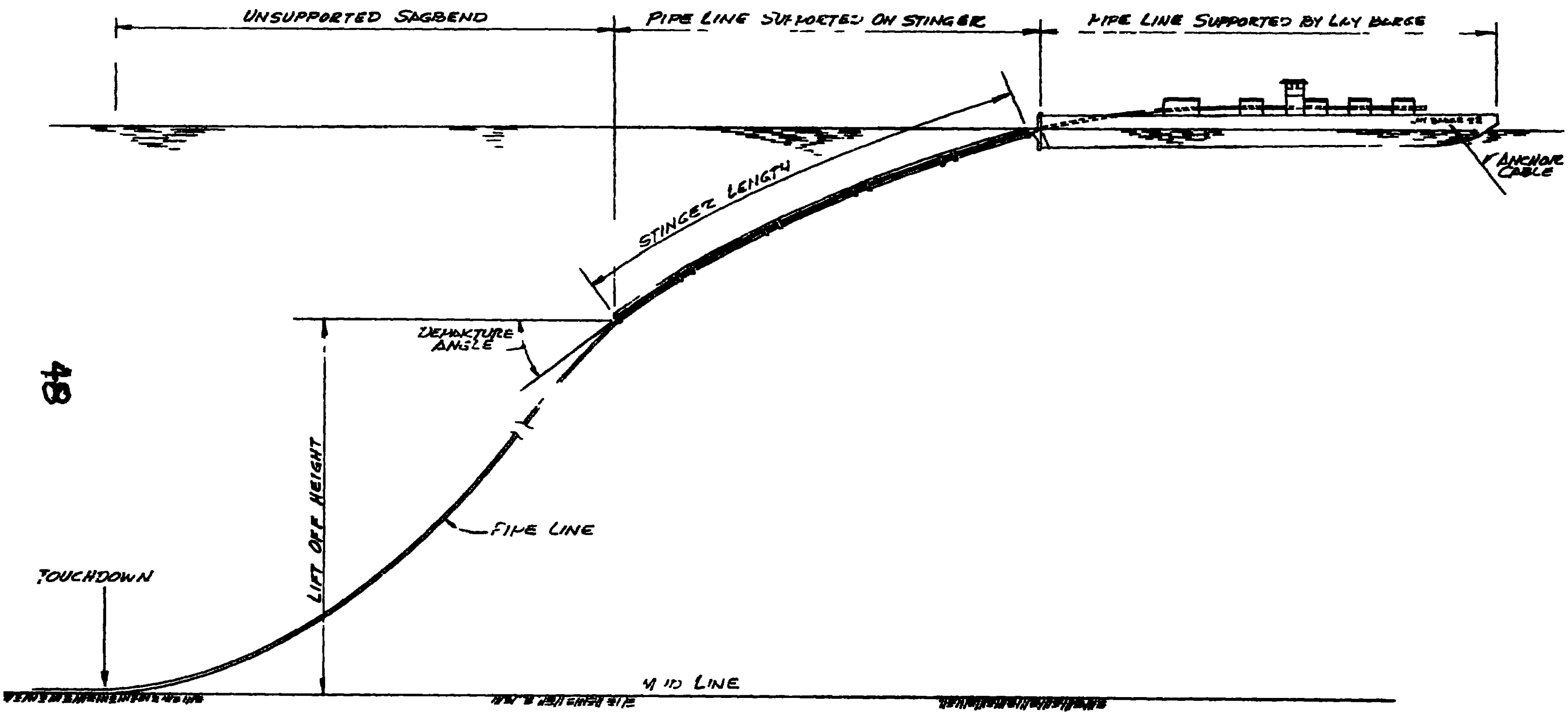

UNSUPPORTED SAGBEND
PIPE LINE SUPPORTED ON STINGER
PIPE LINE SUPPORTED BY LAY BARGE
ANCHOR CABLE
STINGER LENGTH
DEPARTURE ANGLE
LIFT OFF HEIGHT
PIPE LINE
TOUCHDOWN
MUD LINE

FIG. 11

The pipe assembly process utilizes the latest technology and the best welding techniques currently available. All joints are given a complete X-ray inspection for quality and then covered with corrosion resistant material prior to leaving the barge. Offshore pipelines are designed and installed to meet the same codes and specifications as onshore pipelines, such as API, ANSI, ASME, etc. After the line is completed, it is tested to make sure that it has been properly installed and will withstand the anticipated operating pressures safely. The pipe is further protected by cathodic protection systems to supplement the corrosion resistant coating.

For production beyond platform depth range (1200 feet), drilling must take place from floating drilling vessels and production accomplished using underwater wellheads on the ocean floor.

To handle the quantities required, offshore transmission lines have usually ranged between 24 and 36 inches in diameter. At the present time lines of this size extend to approximately 250 feet in the Gulf of Mexico. With existing equipment and utilizing current construction techniques, lines of this size can be layed to water depths of approximately 500 feet; however, both the pipe and the coating must be properly designed for strength and weight characteristics. A 32 inch diameter line will be layed in the North Sea in water depths up to 500 feet in the near future. Also

in the same area, a contract has been let for a 36 inch line in water depths of 540 feet for installation in the summer of 1975. Weather conditions in the North Sea are more severe than the Gulf of Mexico; therefore, if these pipelines can be installed and operated satisfactorily in the North Sea, they should be practical for the Gulf of Mexico also. Large diameter transmission lines can be installed to platforms or terminals appropriately located adjacent to deepwater production. To reach to the deeper water beyond the platform, one or more smaller lines can be used in place of the transmission line.

For gathering lines and pipeline systems to be layed between the shore and platform or transmission line terminal, water depths of 1000 feet-1200 feet could be encountered. It is our opinion that present-day techniques and existing equipment currently in the Gulf of Mexico can lay pipelines of 21 to 18 inches in diameter to this depth with only minor modifications. At the present time no lines appraoch this depth; the deepest pipelines installed in the Gulf of Mexico are in approximately 400 feet of water. When such deep water lines are layed the same proven methods and technology that are now used will be employed. Studies and designs made for areas all over the world, verify that installation in these depths is technically feasible. Figure 12 illustrates a typical profile of a 12 inch pipeline being layed in this water depth using an existing lay barge and conventional type arituclated stinger.

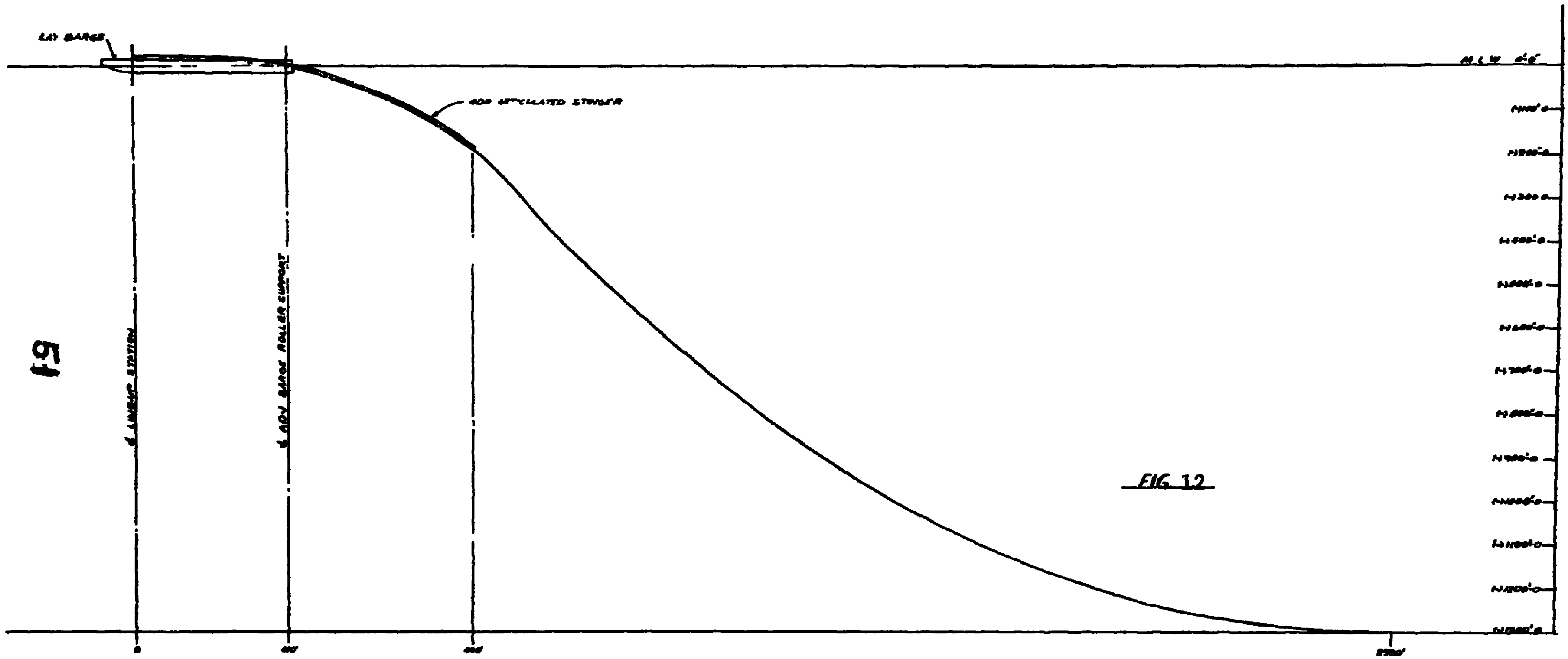


FIG 12

PROFILE OF LAYING CONFIGURATION
WITH ARTICULATED STINGER

Practically all large and intermediate size offshore pipelines are covered with corrosion resistant coating and a concrete coating. The purpose of the concrete coating is to add weight to hold the pipe in place on the ocean floor, primarily to resist currents. The additional weight makes the pipeline more difficult to install. Fortunately, bottom currents are less severe in deeper waters, particularly the currents associated with wave and storm action. This allows reduced weight coating for deep water, which simplifies installation.

Flowlines between platforms and underwater wellheads could reach water depths of 1000 feet to 2100 feet. These lines will range in size from 3 to 8 inches in diameter with a wall thickness relatively large compared to the diameter, which will provide good resistance to buckling and eliminate the need for weight coating. Both of these factors make the pipe more flexible and easier to handle. These flowlines can be installed with a lay barge using techniques similar to those previously described. However, for the deeper water ranges, it will probably be desirable to use an adjustable or inclined "high angle" ramp as shown on Figure 13 . The ramp is adjusted so that the pipeline leaves the barge at the proper angle to reach bottom in a single curve or "sag" bend, similar to a cable held in a catenary. This

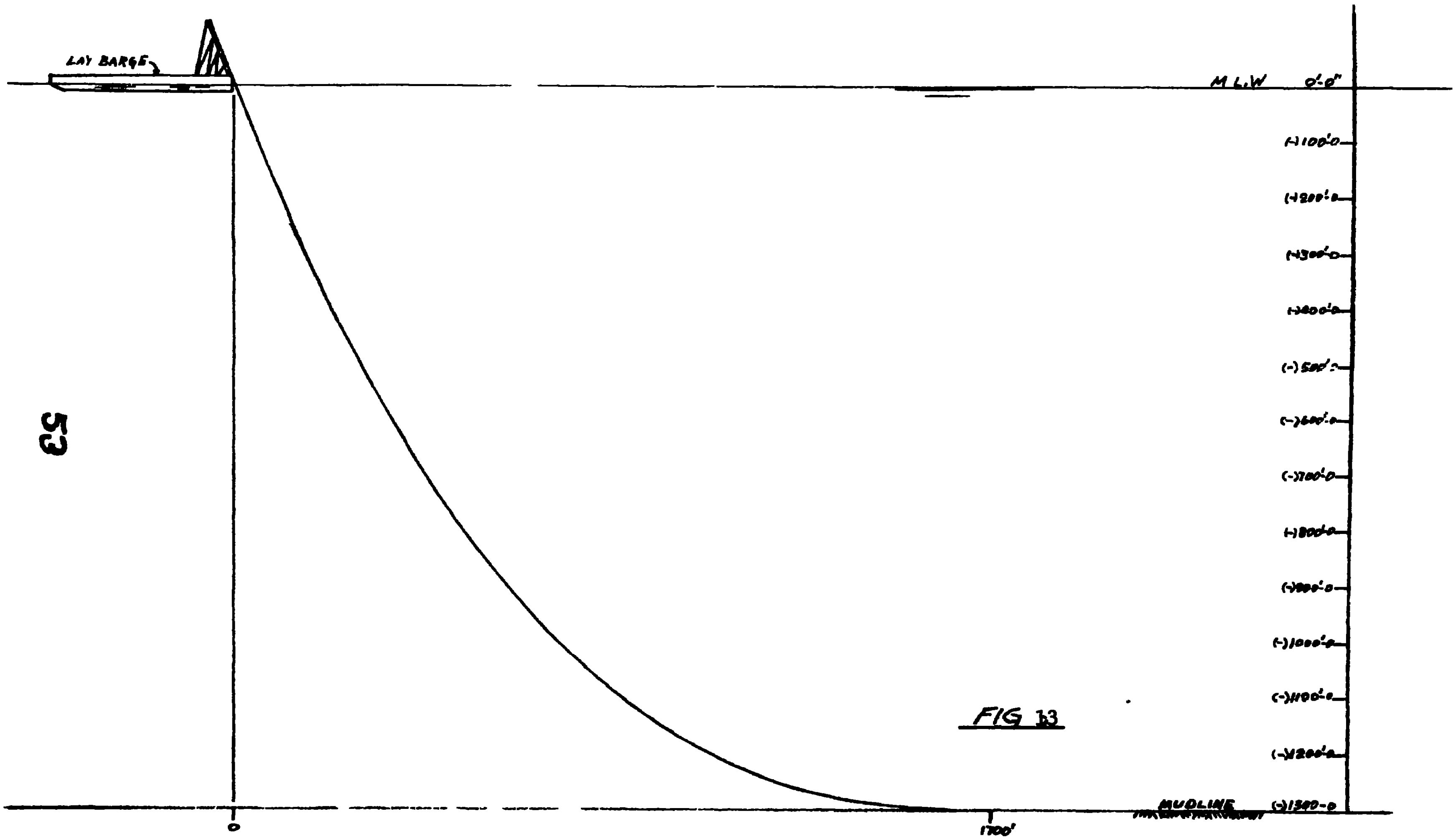

LAY BARGE
M.L.W
0'-0"
(-)100'-0
(-)200'-0
(-)300'-0
(-)400'-0
(-)500'-0
(-)600'-0
(-)700'-0
(-)800'-0
(-)900'-0
(-)1000'-0
(-)1100'-0
(-)1200'-0
(-)1300'-0
MUDLINE
0
1700'

FIG 13

eliminates the need for support from a stinger and reduces the stress in the pipe. The laying rate is reduced as fewer working stations are available. This procedure has been very thoroughly developed, but only limited applications have been made to date.

Holding the barge in position by anchors becomes more difficult as water depth increases, and moving anchors to allow the barge to progress along the pipeline route will be more time-consuming. If this becomes a problem, it may be desirable to provide auxiliary propulsion to assist moving the barge ahead and to counteract the tension which is applied to the pipeline. It may also be desirable to consider a "dynamic positioning" system similar to that used on some floating drilling vessels. This is basically a computer controlled, all-direction propulsion system to hold the vessel in a fixed position reacting to the effect of wind, wave and current. This same concept could be adapted to pipeline installation if sufficient deep water lines are anticipated to justify the cost.

At the present time, it is the opinion of the industry, that it has the capability of laying 24-26 inch diameter pipe in water depths up to 500 feet; 12-18 inch diameter pipe in water depths up to 1200 feet, and 8 inch pipe in water depths up to 2100 feet.

Laying pipelines in deeper water presents technical and economic problems and will be more difficult and more expensive than in shallower water. However, once the pipeline is installed, the completed system should be as reliable as the same pipeline installed in shallower water. It is possible that a line in deep water might be more reliable since it is less subject to the influence of waves and currents from storms.

In depths under 200 feet present OCS administrative procedures requires burial of the pipelines. The minimum depth of burial is 3 ft. except in shipping fairways and anchorage areas, where the minimum depth is 10 ft. Burial is effected by jetting sediment away from underneath the pipeline and allowing it to sink into the resulting trench. The equipment used in this operation consists of a work barge equipped with high volume/high pressure water pumps and air compressors. From the barge, a multiple membered towline consisting of a strength member, water line, and air line extends downward to a U-shaped structure which straddles the pipelines and glides along it on rollers. Affixed to the U-shaped jetting device are several nozzles which direct water and air, under high pressure, ahead and below the pipeline. Sediments are blasted out of narrow trench by the water jets, partially lifted by the air and deflected to the sides by various types of fins. The suspended sediments fall diffusely along either side of the trench. As the jetting device is pulled forward, the pipeline settles into the trench and is partially buried quite soon by the reworked sediment as it slips and settles back into the depression. Complete burial and restoration of original bottom contours may require additional time. In shallow waters, experience has shown that contour restoration to be quite rapid, whereas in deeper waters, more than a year may be required.

Even though a buried line is protected from fluid forces it is not necessarily stable. 1/ If it is too light, it will gradually work its way up through the soil and become exposed to the water forces. If it

---

1/ Milz, E. A. and D. E. Broussard, 1972. Technical capabilities in offshore pipeline operations to maximize safety. Paper presented at 1972 Offshore Technology Conference, Dallas, Texas, May 1-3, 1972.

is too heavy, it will gradually sink in the soil and impose additional tensile stress in the line. Design procedures for determining the vertical stability of the line in sands and clays have been developed and are available in the industry.

Difficulties have been experienced in burying pipe in cohesionless sands. 1/ In this case the sand will often refill the jetted trench before the pipe can settle into it. Another method, fluidization of the sand, enables successful burial in this type of substrate.

In waters beyond the 200-foot contour, pipelines are not buried. Industry spokesmen maintain that as yet, burial in waters deeper than 200 feet is not economically feasible but that new equipment could be available in the future.

To prevent corrosion, pipelines are carefully coated with such materials as epoxy compounds or thick asphaltic mastic. If extra weight or mechanical protection is needed, these, in turn, are covered with a layer of dense concrete. The lines are protected from electrolysis by both impressed-current systems and by sacrificial anodes (zinc is commonly used). Corrosion prevention measures are now required by 49 CFR Part 195. Although offshore pipelines are relatively inaccessible as compared to onshore pipelines, they nonetheless can be repaired by divers. Experimental dives have been made to 1,000 feet, but work at this depth is difficult and expensive. Methods of using submersibles to latch on to a subsea line and repair it with mechanical arms and special tools are under study and nearing the point of practical demonstration.

1/ Ibid.

As in the case of workover operations, the expense of the pipeline installations, coupled with the catastrophic implications for the local marine environment should a major break occur, have combined to dictate a highly conservative design, emplacement, and operating philosophy.

As the pipeline construction approaches and traverses the shoreline, it is buried deep enough to avoid its being exposed by storm-associated beach erosion. From this point the pipeline construction will be extended toward a storage facility, wharf facility, or a major existing pipeline system, in turn leading to a processing facility, refinery, or interstate gas line.

b. Pipeline--Operation and Maintenance

The safe operation and maintenance of a pipeline system requires several redundant monitoring systems to ensure the integrity of the line and detect leaks. The primary leak detection system in use (required on all lines built after March 31, 1970 by 49 CFR Part 195.406 and 195.408) is a set of automatic pressure sensing recorders on both ends of each pipeline system. These devices are equipped to either shut down the flow automatically or sound an alarm to alert personnel of an abnormal pressure level. In this way, a leak of substantial rate is detected immediately. This system is insensitive to leaks which do not produce a decrease in line pressure greater than 300-500 psi. It is essentially a safeguard to prevent the escape of large volumes of oil due to a catastrophic line break.

The second system of leak detection is the routine patrolling of the offshore wetlands routes by boat or aircraft, and onshore by wheeled vehicle or aircraft. A minimum patrolling frequency of intervals between inspections not exceeding 2 weeks is required by 49 CFR Part 195.412, but in actual practice is performed more often. This type of monitoring would result in the detection of all sizes of leaks of course, but would be of little consequence in preventing the loss of a large amount of petroleum in the event a large line were severed. The appeal of a system of regular pipeline patrolling is that it allows detection of small leaks and therefore complements the pressure-sensing system described above. With the present day volume of airborne and waterborne traffic over the oil producing area of the Gulf of Mexico, it is considered highly improbable that any spill would go undetected for any appreciable length of time.

The third system for leak detection consists of a series of volume-recording flow meters on either end of a pipeline system. Because nearly all crude oil moves from OCS areas to shore by common carrier lines, it must be metered in the offshore pipeline gathering system and again at the onshore pipeline terminal in order that each producer be properly credited for his share of the common stream. The flow sensors continually measure input and output in real time; thus when attendant personnel record these readings for inventory control they are able to discover a decrease in output which would indicate the possibility of a small leak. This is usually done on a shift schedule, once every eight hours or more frequently.

One more safety feature which would be built into all pipelines resulting from this proposal, according to industry spokemen, is that remotely operated mainline block valves will be provided at remotely controlled pipeline facilities in order to allow isolation of segments of the pipeline. Isolating valves are required by CFR 195.260 and remote operation of these valves, which voluntary, would be one of the primary objectives of a remote controlled pipeline facility. Table 4 shows the relationship between the diameter of a pipeline and the volume contained per mile of line.

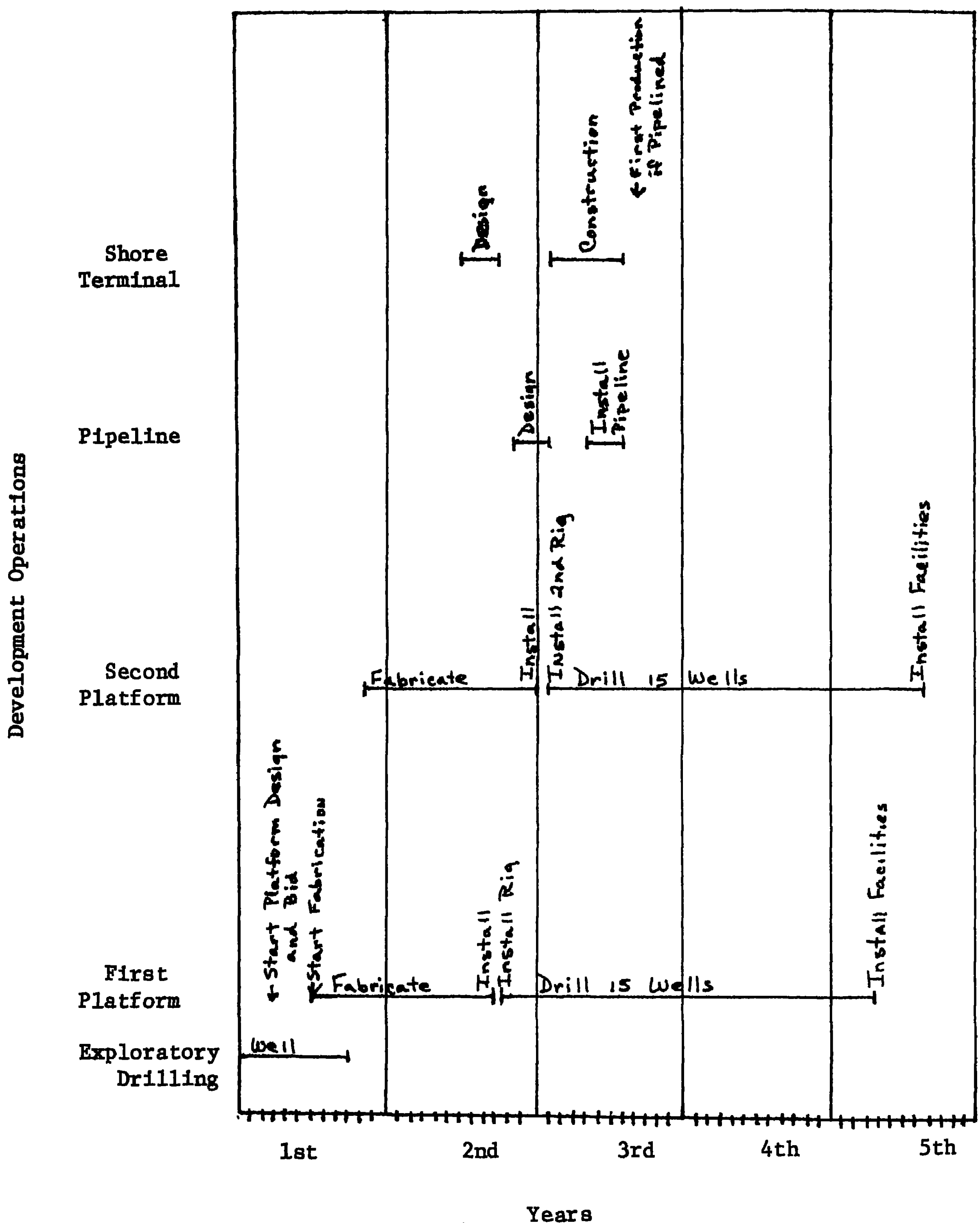
Table 4. Length/Volume Relationship of Linepipe

Size (inches ID)	Length Required to Hold 1000 bbl. (miles)	Barrels Per Mile of Line
2.067	45.6	22
4.026	12.0	83
6.026	5.3	189
8.071	3.0	334
10.020	1.9	515
12.090	1.3	750
24.000	0.3	2954

5. Terminations of Offshore Oil and Gas Operations

According to industry estimates, with proper placement of wells and sufficient pipeline capacity, a gas reservoir could be profitably drained in as little as ten years. In contrast, some oil reservoirs have been produced for over twenty years in offshore areas. When the reservoir has been depleted to a level where it cannot be profitably produced, operations are terminated. During abandonment, the wells are plugged with cement, the casing severed at least 15 feet below the mud line, the platform removed, and all obstructions cleared from the area. All that remains is the pipeline system. Frequently, major trunklines can be used for future oil and gas production from adjacent areas, but smaller spur lines are abandoned in place. Pipeline abandonment consists of first purging the lines of entrained hydrocarbons by water flushing and then severing the ends below the mud line. See Fig. 14 for a typical time table of lease development.

Figure 14. Typical Time Table for Lease Development



B. General Environmental Impacts of Offshore Oil and Gas Operations

Introduction

The development and production activity following this proposed sale could result in a variety of impacts on the natural environment, on other Gulf of Mexico resource uses, on air and water quality, on land use patterns, on the social order, and on the economy. In the light of existing operating practices, regulations, economics, and technology, some impacts are the unavoidable result of routine operations and the probability of their occurrence is 1, or 100%. Other impact-producing events must be viewed as accidental, not a part of day-to-day operations, but caused by occasional human error or equipment failure. Still other impacts can be controlled or avoided by safe operating practices and by regulations.

This introductory section is devoted to setting the stage for the discussion of actual impacts by briefly describing impact-producing operations and events, and where possible, citing statistics and examples. Each subsection contains an estimate of the magnitude or extent or duration of impact which can be expected if the proposed lease sale is held. The reader is reminded that routine oil and gas operations are described in Sec. III.A.

1. Impacts Resulting From Day-to-Day Operations Which are Unavoidable Under Existing Operating Practices, Regulations, Economics and Technology

a. Discharge of Cleaned Drilling Muds and Drill Cuttings

The drilling mud and casing programs, and drill cuttings volume of a representative 10,000-foot offshore well were

discussed in Sec. III.A.3.b. Most production on the Louisiana OCS comes from formations in the depth range of 8,000-12,000 feet. Many wells resulting from the proposed leasing could be drilled and produced within this depth range. Drilling wells to the depth of 10,000 feet, would require approximately 7,000 bbl. of seawater drilling muds containing almost 300 long tons of commercial mud components mixed with seawater. The volume of cuttings generated by the 10,000 foot well was shown in Table 1.

During the course of drilling this representative 10,000 foot well, almost 700 tons of drill cuttings and some commercial mud components will be discharged overboard.

The Geological Survey has estimated that between 700 and 900 wells would be required to develop the proposed acreage. At this time it would be premature to narrow the range of possible wells or predict the numbers of wells drilled to around 10,000 feet and those drilled to deeper or to lesser depths. The drilling of 900, 10,000 foot wells would yield approximately 550,000 tons of drill cuttings and up to 100,000 tons of commercial mud components.

Drill cuttings are, of course, composed of shattered and pulverized sediment and underlying native rock. In considering impact, it is also relevant to examine those components of the drilling mud which will be discharged. The following table (Table 5) briefly identifies these components. The reader should bear in mind that this discussion is based on the representative well drilling mud program used in Sec. III.A.3.b. and other compounds, listed in Table 2 of that section, could be added in special cases.

The Environmental Protection Agency view is that drilling muds must be considered harmful and are subject to EPA permitting procedures and effluent limitations.

b. Discharge of Produced Formation Water

There is no geological evidence on which the amount of formation waters produced from wells resulting from this proposal can be predicted. Several years ago an estimate was made that all producing OCS wells offshore Louisiana (about 3,500) produced 240,000 bbl. per

Table 5. COMPONENTS OF DRILLING MUDS WHICH ARE NORMALLY DISCHARGED INTO THE SEA

Substance	Source	Use	Composition	Known Hazard
Attapulgite clay	Quarry	To cause gelling of salt water based muds	A light green magnesium-rich clay, quarried as "Fullers Earth"	NONE
Bentonite Clay	Quarry	To cause gelling of freshwater based muds	A light-colored montmorillonitic clay; slippery sticky when wet; swells to 10-20 times its dry volume	NONE
Caustic soda	Electrolysis of sodium chloride brine	For pH control	Sodium hydroxide, NaOH	Corrosive in concentrated form; not harmful after mixing into mud at low concentration and allowed to react
Ferrochrome lignosulfonate	Digestion of wood by sulfonate process; removal of cellulose; reaction with chromium compounds	Dispersant and emulsifier	Ferrochrome salt of lignosulfonic acid; content: Fe-2.6%, Cr-3.0%, S-5.5%	Possible chromium toxicity in pure form, none known from diluted form in muds
Organic polymer	Chemical process with plant starch, wood fiber as raw materials	Conditioner, texturizer	Starch, cellulosic derivatives	NONE
Proprietary defoamer	Soap making process	Defoamer	Aluminum stearate Al $[CH_3 (CH_2) 16] 3$	NONE

day of formation water. A recent check showed that the Florida Jay Field, just north of the western part of the area included in this proposal, produced very little water at all. It is well known that some hydrocarbon reservoirs contain substantial amounts of water, whereas others contain almost none. Therefore, no predictions will be made at this time concerning the amount of formation water production which may be expected. While substantial amounts will likely be discharged into the sea, a significant proportion will also be reinjected into subsurface formations.

The mineral content of formation waters also cannot be predicted. Some fields in Texas produce almost pure water whereas, one field in Michigan produced brines containing 624,798 ppm mineral salts. The average total dissolved solids of 76 samples from southern Louisiana and the Outer Continental Shelf was found to be 112,513 milligrams per liter (mg/l) with a high of 270,400 mg/l and low of 61,552 mg/l. They commonly contain varying amounts of iron, calcium, magnesium, sodium, bicarbonates, sulphate, and chloride, with sodium and chloride being the most abundant ions. For informative purposes, refer to table 3 which shows the content of three representative brines (formation water) from offshore Louisiana. They are classed as formation waters containing (1) high solids, (2) average solids, (3) low solids.

In addition to water quality degradation from high mineral content and low dissolved oxygen, a very small amount of oil is entrained in formation waters which are discharged into the sea. OCS operating orders require that the average oil content at the point of discharge must not average more than 50 ppm. EPA is presently developing effluent limitations for discharges from production platforms which will be based on technological feasibility. OCS operations will be subject to these limitations.

The MIT Offshore Oil Task Group (MIT, 1973) has estimated that biologically, this could be the most significant of all minor discharges, for this oil could contain a high percentage of water soluble aromatics. They note, however, that there appears to be no data on the fractional composition of the oil remaining in the water after treatment in the oil/water separators. The separation process is ineffective against that portion of the oil which is dissolved into the water.

c. Disposal of Solid Waste and Sewage

See section III.A.3.d. for a description of source, content, treatment, and disposition. No prediction of volume or potential impact will be made at this time.

d. Disruption of Sea Floor and Resuspension of Sediments During Pipeline Burial

See section III.A.4.a. for a description of this operation. During pipeline burial, a large volume of sediment is dis-

rupted and resuspended for a short time in the overlying water. Unfortunately, it is impossible to calculate a reasonably accurate volume of material that is reworked because the width of the trench varies greatly with compactness and the fluidization point of the sediment. A very rough estimate of the trench dimensions is 5 feet deep by 6 to 12 feet wide. Assuming a parabolic cross-section, approximately 4,000-8,000 cubic yards per mile would be disrupted, some of which would be resuspended. This figure cannot be applied to Geological Survey's prediction of 1300 miles of pipeline resulting from this sale because some of that mileage includes sections in water deeper than 200 feet, where burial is not now required, sections of the gathering systems around groups of platforms where burial may not be required, section in State waters where the Department has no jurisdiction and cannot require burial, and sections laid onshore. At some future date, when exact pipeline routes are drawn, our figure may be used as a multiplier to determine the total volume of sediments disturbed.

e. Digging of Trenches and "Push-ditches"

The volume of material reworked is of little concern here; instead, the width of upland or wetland disturbed and devegetated is of importance. Our rough estimate is that perhaps 50 to 60 feet of land will be extensively driven over by construction and burial equipment, resulting in some damage to vegetation and compaction of soil in vehicle tracks. Actual disturbance of soil and complete removal of vegetation will occur in a band of perhaps 30 to 40 feet. In marsh-

lands where the substrate is not solid enough to permit burial of pipelines (as in much of eastern coastal Louisiana) "floatation" canals are constructed. This practice leaves an open canal on the order of 30-60 feet wide. Impacts caused by this type of canal include loss of marshland habitat disruption of drainage systems, saltwater intrusion, and degradation of aesthetic values. Saltwater intrusion and erosion can be prevented or retarded by installation of bulkheads. Many private landowners require this and it is common practice on pipeline canals on state-owned lands. At this time we do not know how many miles of pipeline will be buried onshore through wetlands or elevated terrain, but it is expected that probably no more than one new pipeline will be brought ashore as a result of this sale.

f. <u>Placement of Temporary and Permanent Platforms, Boats, Barges, and Pipelines in Conflict with Commercial Fishery Trawling Operations and Ship Navigation</u>

As a result of this proposed sale, Geological Survey estimates between 100 and 200 platforms will be placed in this area. As discussed in section IV.D., there are four factors that will affect the commercial fishing in this area. These are (1) the removal of sea floor from use by trawlers, (2) the creation of obstructions on the sea floor that cause damage to trawling nets, (3) the possible contamination of catch by oil, and (4) direct lethal or sublethal effects on fish.

Ship traffic will not increase as a result of this sale thus the only additional hazard will be the addition of incremental structures in the area. Records of ships colliding with platforms are discussed in this section. (see III.B.2.b.(6))

Geological Survey also predicts an additional 1300 miles of pipeline in the proposed area. Administrative procedures require the burial if common carrier pipelines in water depths less than 200 feet. However, it should be noted that 128 of the proposed 295 tracts lie partly or completely beyond the 200 foot contour.

g. Placement of Structures, Pipeline Burial Cuts, Ancillary Onshore Facilities Where They May Degrade the Scenic Values of the Area

As stated in section IV.H.2., 78 of the 295 proposed tracts lie within 17 miles of the shoreline which means that some portion of a 100 foot structure constructed on one of those tracts could be visible from the mainland shoreline or one of the barrier islands. The probability that permanent platforms will be erected on each tract, based on past exploration success rate, is about 35%. This is to say that approximately 1 out of every 3 tracts offered for lease will eventually require the erection of platforms for its development. It is estimated that each full tract (5,760 acres) developed will average two structures per tract.

Ancillary onshore facilities will be constructed where the pipelines come ashore. These facilities will require approximately 40 acres each for construction and operation. And, as estimated in section IV.H.2., the negative impact on the aesthetic values of the pipeline burial cuts will diminish in about a year.

2. Impacts Resulting from Accidents

In any complex industrial operation involving heavy equipment, flammable materials, work at sea, large numbers of employees, and

a large-scale reliance on complex technology, it is inevitable that accidents will occur. Thus, although theoretically avoidable, impacts resulting from accidents can be viewed as unavoidable in a statistical sense. It has been possible to gather data and derive statistical frequencies for some of these events, which are presented below. An attempt has also been made to predict the number and magnitude of impact producing events which will result if this proposed sale is conducted.

a. Natural Gas Leaks Associated with Blowouts

Information furnished by the Geological Survey for the period 1956-1973 lists 38 gas leaks associated with well blowouts during OCS oil and gas operations in the Gulf of Mexico. Eleven of these incidents involved fires and five were associated with oil or condensate spills. The duration of the blowouts ranged from two hours to over seven months. Several incidents resulted in the injury and death to members of the crew, and damage or loss of valuable equipment. Environmental damage has never been observed to result from natural gas blowouts and no estimates of the amount of gas lost have been made.

b. Oil Spills Greater Than 50 Barrels in Size

Note that we do not entitle this section "Major" or "Massive" or "Large" etc. Several governmental agencies have endeavored to establish a system for oil spill size classification, i.e., the U.S. Coast Guard, U.S. Geological Survey, Environmental Protection Agency. Because these classification systems are not similar, we choose not to adopt any of them, but instead, we believe any spill of 50 bbl. or more is significant enough to receive individual considera-

tion. Data supplied by the Geological Survey for the period 1964-April 1974, indicate a total of 44 oil spill incidents connected with Federal OCS oil and gas operations in the Gulf of Mexico involving 50 bbl. or more of oil and condensate.

The estimated total volume of oil spilled during this period as a result of these incidents is slightly less than 320,000 bbl. A distribution of these 44 incidents as to type and amount spilled is presented in Fig. 14.

In the following discussion of oil spills by type, several predictions will be made by comparing the volumes of these spills and the total production of oil and condensate during the same period, 2.9 billion bbl.

(1) Pipeline Accidents

During OCS operations, more oil has been spilled from pipeline accidents than from all other sources combined. In October of 1967, a vessel underway during a storm and with its anchor inadvertently left out, snagged and severed a pipeline about 20 miles west of the mouth of Southwest Pass, Mississippi River Delta, Louisiana. The resulting spill went undetected for nearly two weeks, releasing over 160,000 bbl. of oil into the sea. In March of 1968, another anchor/pipeline accident resulted in a 6,000 bbl. spill. In February of 1969, a pipeline leak released over 7,500 bbl. into the sea; the cause was never determined. In April 1974, a pipeline break, probably caused by a ship's anchor dragging during a storm, released 19,833 bbl. into the ocean.

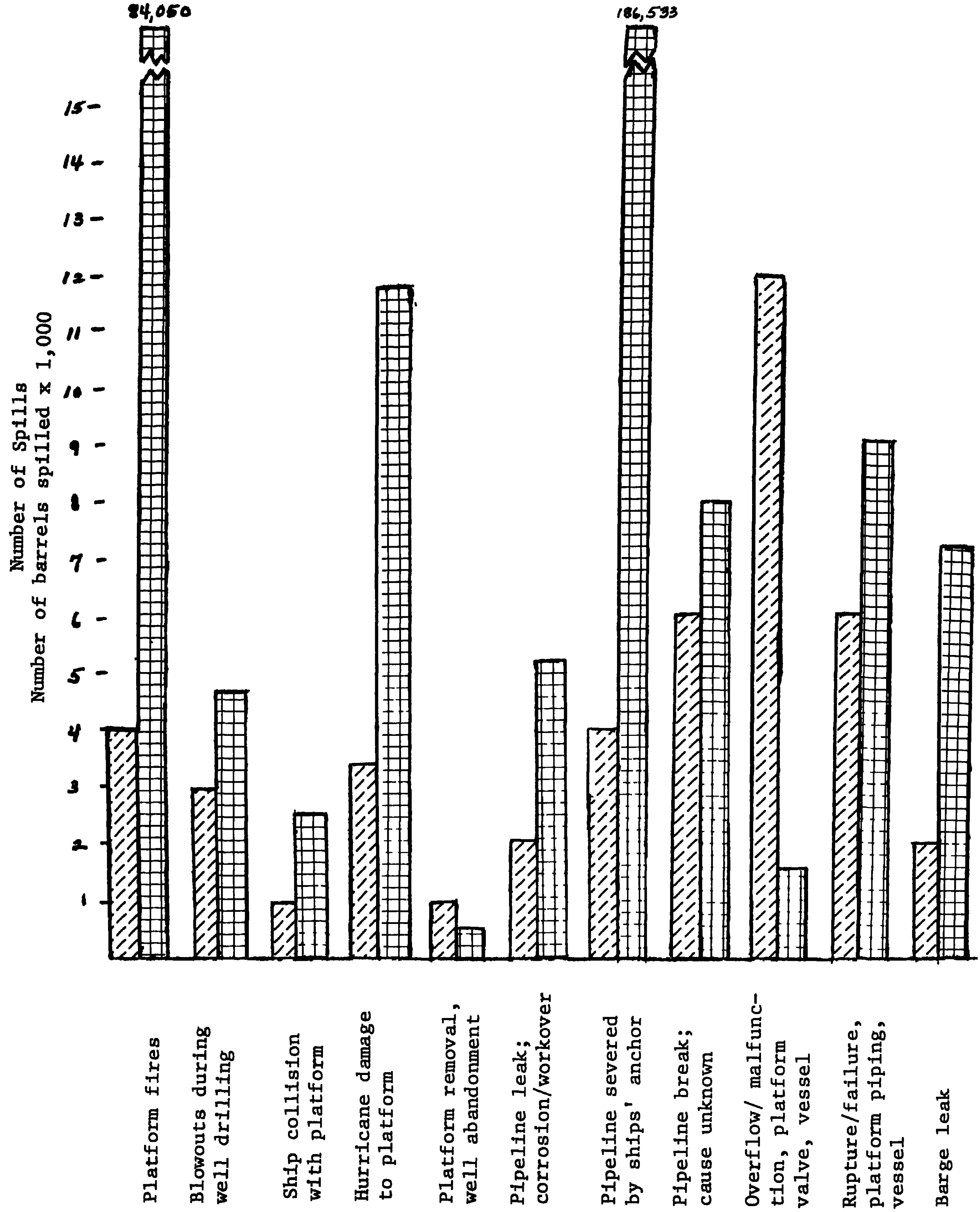


Figure 14. Oil Spills $\geq$ 50 bbl. Number and Amount
(Data from Geological Survey.)

Amount of Oil Spilled — Number of Spills

Beginning in 1969, several actions were undertaken to decrease this inordinately high volume of spillage per accident and to keep the frequency of occurrence low. Since 1969, the Bureau of Land Management, through administrative procedures, has required the burial of all new common carrier pipelines with a minimum of three feet of cover out to a water depth of 200 feet. Where the pipelines cross shipping fairways and anchorage areas, they must be buried at least 10 feet deep. The 10-foot burial in anchorage areas and shipping fairways is a U.S. Army Corps of Engineers requirements. The New Orleans District Office, Permit Branch, of the Corps reported that conventional jetting is used to bury pipe in soft bottoms, and a hydraulic dredge is used in harder bottoms. An inspector from the Corps is occasionally present during trenching operations; otherwise, verification is made by reviewing the pipe-laying "as-built" plans. In water depths of less than 200 feet, only the lines in the gathering system between adjacent platforms of a particular oil or gas field may remain unburied. Permits to construct such lines are granted by the Geological Survey and the decision to bury is made on a case-by-case basis.

In connection with regulations formulated by the Office of Pipeline Safety (OPS), Department of Transportation (49 CFR Parts 192 and 195) offshore pipelines were required to be coated with tightly bonded, moisture impervious materials, followed in many cases by a layer of

dense concrete for mechanical and corrosion protection. In addition to coatings, impressed currents or sacrificial anodes were required to protect against electrolytic corrosion. The OPS regulations also require continuous line pressure monitoring with some type of communication system (a built-in alarm or automatic shut-down system is normally used), and regular inspection of the pipeline route for leaks and other irregularities.

Other features used by industry also serve to mitigate against accidents: continuous metering systems, automatic high pressure shutdowns, and remotely controlled mainline block valves that can isolate sections of a line. A more complete discussion of all of these systems is presented in Sec. III.A.

Caution should be inserted at this point. In established oil and gas fields where older lines are present, corrosion will be in a more advanced state, the line may be poorly buried if at all, and all of the above-mentioned requirements for safety and control features may not apply. In fact, industry spokesmen have estimated that 48% of all pipeline leaks occur in lines that have been in use for 15 years or more.

Prior to the new regulations concerning pipelines, the spillage rate was .0125% of the total production. Since 1970, with the regulations in effect, the spillage rate is .0017%, about an order of magnitude less. If spillage continues at this rate, 776 bbl. of oil per year could be spilled as a result of pipeline leaks from this sale.

Although the new regulations have brought the spillage rate down, the problem of pipeline leaks from anchor dragging has not been completely resolved. As a part of our pipeline management program, we will continue to investigate the economics and the burial system of pipelines. In addition, BLM is presently determining exact locations of pipelines, and plotting them on National Ocean Survey (NOS) Navigation charts. This information will help to mitigate the problem of pipeline leaks due to anchor dragging.

Strictly on a judgment basis and with no references to existing statistics, it is estimated that pipeline breaks may range from zero in the early years to three incidents per year in later ($\pm$20) years.

(2) Oil and/or Gas Well Blowouts During Drilling

The control of imminent blowouts by increasing mud weight and activation of blowout preventers is discussed in Sec. III.A. In the event the control systems fail, however, the well will blow out of control, and if it is an oil well, it will release large quantities of oil into the environment. If a gas well blows out, the escaping gas either burns or is dissipated in the atmosphere.

One example of a blowout during well drilling is the Santa Barbara incident.

SANTA BARBARA SPILL 1/

On January 28, 1969, a blowout occurred below Union Oil Company's fixed drilling platform A in the Santa Barbara Channel, about six

---

1/ Straughan and Kolpack (1971).

miles southeast of Santa Barbara, California. This blowout and spill occured through a pre-existing fault in the ocean floor adjacent to the well after gas under high pressure from a deep reservoir was accidentally injected into shallow reservoir sands. The resulting build-up of pressure in the shallow reservoir sands soon exceeded the strength of the overlying rock layer and caused a rupture to occur. The rupture formed a fissure zone, thus opening an avenue of communication between the hydrocarbon reservoir and the seabottom (Reinhart, 1970).

Total initial spillage was estimated by the Geological Survey to be 10,000 bbl., with subsequent leakage amounting to about 8,500 bbl. Other estimates of spillage range from 70,000 to 700,000 bbl. 1/

According to accident data for the Gulf of Mexico supplied by Geological Survey, the numbers indicate one blowout per 3,900 wells drilled or .026% of wells drilled blew out, spilling an average of 2,100 bbl. of oil per blowout. Using the average between the maximum and minimum number of wells estimated to be required for this proposed sale (900-700), the probability for a polluting blowout occurring at all is $\frac{800}{3900}$ or 0.21. If there is no blowout, there is then of course, no oil spilled. Should a blowout occur, the volume of oil that might be spilled is impossible to estimate; the historical average, as indicated above, is 2,100 bbl. per blowout.

1/ Testimony of Dr. Carl H. Oppenheimer, OCS Public Hearing of August 23, 1972, New Orleans, Louisiana.

(3) Oil Spills Resulting from Platform Fires

Platform fires can be ignited by a variety of events. Most are undoubtedly caused by combustible hydrocarbon liquids or vapors being brought into contact with arcing electrical devices and overheated mechanical devices; more rarely they could be ignited by lightning or static electricity. Sometimes, platform fires first involve the accidental ignition of fuel, solvent, or heat exchanger fluids. If caught soon enough, these small fires are usually controllable, but once a storage tank or well catches on fire, major structural damage occurs and adjacent producing wells on the platform may have their piping severed and also contribute to the fire. It is for this reason that we have chosen to group accidents of admittedly diverse causes under the heading "platform fires". By far, the vast majority of fires are extinguished quickly, before serious damage is done. But once a fire burns out of control, it usually leads to damage of the well heads and multiple well involvement. As was stated in section III.A. downhole safety shut-in devices have a poor record of performanace to date.

If producing wells are damaged in a way that allows them to flow freely and be ignited, they are usually allowed to burn while operations are underway to control the wild wells from a remote location. In this way, a high percentage of the hydrocarbon

liquid expelled by the well is burned. This in turn results in less fire hazard from floating oil near control operations such as relief well drilling and in lower levels of ocean pollution. If a blowing well is releasing mostly or entirely natural gas, the possibility of ocean pollution is minimal. However, the safety of personnel and the security of the platform or drilling structure are imperiled during a fire. The decision whether or not to extinguish a gas fire depends on the circumstances of the moment. For example, it might be advisable to allow a gas well fire to burn while remedial action is being taken, as long as the structure and personnel are not in jeopardy. This would preclude accidental ignition while personnel were in the area of gas accumulation. The overall thrust, however, is to extinguish the fire quickly and bring the well under control.

An example of an apparently spontaneous platform fire which resulted in the ignition of several producing wells and extensive damage to the platform is the Chevron Fire of 1970. 1/

On February 10, 1970, fire was observed on Platform "C" shortly after midnight from an adjacent platform. Platform "C" is located in 40 feet of water about 75 miles southeast of New Orleans, Louisiana. Field personnel boarded the burning platform but had

---

1/ U.S. Dept. of Interior (1970).

to evacuate immediately because of the intense heat. During the following month, planning, construction and assembly of equipment for extinguishing the fire and controlling the anticipated oil spill was carried out. From March 10 through March 31, several methods were successfully used to control six of the seven wild wells on the platform (one well sanded up and plugged itself). These included dynamite, relief well drilling, wellhead repair, weighting and sealing chemicals, and activation of downhole safety valves.

Reliable estimates placed the total volume of oil spilled at about 30,000 barrels. Oil from the spill was a light crude, containing a high proportion of lower boiling constituents and a relatively low concentration (about 10%) of aromatic hydrocarbons. Through a fortunate set of circumstances, the oil was sprayed high into the air under great pressure and frequently into considerable wind, so that far more evaporation took place than usually occurs during a spill. Samples collected 500 feet from the platform and analyzed by Federal Water Quality Administration (FWQA) laboratories showed a loss in volume of 16%, all in the lighter ends. Also, about 5,000 bbl. of oil were removed by skimming. Some 1,500 bbl. of chemical emulsifier were used during the spill as well.

Accidents caused by human error during routine rework, maintenance and repair have resulted in at least two large spills of oil, along

with destruction of platforms, the loss of a work vessel and several human lives. On May 28, 1970, renovation and repair work was being carried out on a platform in Galveston Block 189-L, offshore Texas. The platform had been shut-down and workmen were sand-blasting, painting, torch-cutting, and welding. When welding was attempted on a line leading to a storage tank containing 2,000 bbl. of crude oil, a series of explosions occurred, resulting in the death of five workmen and injuries to six. Burning oil spilled onto a nearby service boat, nearly destroying it, and about 100 bbl. also reached shore, polluting Galveston beaches (National Transportation Safety Board, 1970).

The Bay Marchand Fire (Shell Fire and Spill) of 1970-71 was ignited as a result of human error. The plastic coating in the tubing of one well sloughed off and plugged the tubing. During cleaning operations, workmen failed to close well control valves completely for a brief period while the well was left unattended. Plastic, used as a corrosion preventive in the tubing of well B-12, had sloughed off and lodged in the gate of the master valve. As the gate was closed, this plastic compressed, preventing complete closure of the valve, but giving an indication that the valve was closed. The well appeared to be shut-in, but after 30-40 minutes the plastic began to slip through the gate opening and was finally released, thus opening the well to the atmosphere and allowing oil to escape.

Falling debris and intense heat from the resulting ignition and fire damaged ten of the other 21 wells on the platform; thus 11 wells in all were contributing hydrocarbon to the fire. Four workmen died immediately and 36 were hospitalized. After five months the last blowing well was capped (Berry, 1972; Nelson, 1972). An undetermined amount of petroleum was consumed by the fire and 53,000 bbl. spilled into the sea. 1/

During the history of OCS production there have been many fires of varying sizes. Most have been extinguished before serious damage and pollution occurred. Of 81 recorded explosions and fires, only four have resulted in pollution of the sea by oil. However, the volume spilled, an estimated 84,050 bbl. is significant. Of even greater significance is the unfortunate injury of 120 men and death of an additional 59 (as listed in Geological Survey records).

For the purpose of predicting platform fire-related pollution that could result from this proposal, the incompleteness of the existing data on number of producing oil wells and number of platforms requires that we consider instead, the relationship between pollution and total oil production. The following assumption is made:

- hazards leading to platform fires and technology used to control fires and blowing wells for the present proposal

---

1/ EPA estimates, based on remote sensing surveys, are about double the 53,000 bbl. estimate of the Geological Survey.

will not be significantly different from those present in operations in the western Gulf.

It is significant that OCS orders now require all new OCS completions (with shut-in tubing pressure less than 4,000 psig) to be protected with surface actuated subsurface safety devices, thus eliminating blowouts due to faulty and/or sand cut velocity-actuated downhole safety devices. OCS Order No. 5 also requires that wells with shut-in tubing pressures greater than 4,000 psig shall be protected with a subsurface controlled subsurface safety device.

During the years 1964-April 74, total oil and condensate production from the OCS Gulf of Mexico amounted to about 2.9 billion bbl. During that same period Geological Survey accident records indicate four incidents of platform fire-related pollution resulting in a spillage of 84,050 bbl. This amounts to a spillage rate of 0.0029%. If we apply this to the maximum production rate for this proposal (up to 125,000 bbl./day or 45,625,000 bbl./year) 1,323 bbl. per year of spillage may be projected by this method of calculation. Based on the above assumption, we conclude that the maximum size of a single spill in the future most probably would be limited to the volume of flammable material in storage on the platform at the time the fire started.

(4) Pollution Caused by Hurricanes

Whereas damage and subsequent pollution caused by the passing of a hurricane is not an accident in the strictest sense, lack of adequate preparation for the onslaught of a hurricane can be viewed as an avoidable "accident". The only available data on the impact of hurricanes to pipelines is Blumberg's report of 1964. According to his study, buried pipelines received no damage from either hurricane Carla, 1961 or Flora, 1963.

Accident records for the Gulf of Mexico OCS indicate that on October 3, 1964, a hurricane passed over the water off central Louisiana and destroyed three platforms, resulting in the spillage of almost 11,900 bbl. of oil. All of the oil was lost from tanks on the platforms used to store produced oil prior to transshipment by barge.

Since 1964, three major hurricanes have hit the east half of offshore Louisiana where extensive offshore petroleum production takes place. While causing financial damage to the offshore oil industry, they have not resulted in major pollution incidents from operations in Federal waters, although smaller scale incidents have occurred. The threat of significant damage and major pollution incidents caused by hurricanes should not be discounted, however. The latest of these was hurricane Camille. On August 17, 1969, she passed along the eastern flank of the

Mississippi delta of Louisiana and into the Mississippi Gulf Coast. 1/ Camille's top winds were estimated at 201.5 miles per hour, and the barometric pressure in he calm eye dropped as low as 26.61 inches of mercury. The hurricane surge at Pass Christian, Mississippi, was recorded at 22.6 feet above the normal level of the Gulf. Offshore installations in areas near South Pass, Main Pass, and Breton Sound were badly damaged. Prior to arrival of the storm, the Offshore Operators Committee advised tapering off production operations, and before the storm hit, 4,000 wells in state and Federal waters were shut-in and 3,000 workmen evacuated. Because of this caution, no injuries to petroleum production personnel were reported and there was a total absence of blowing wells and few leaking wells. The U.S. Geological Survey reported no oil slicks in Federal waters and only one in State waters.

During the onslaught of Camille, one production platform was destroyed and two were damaged, two drilling rigs were destroyed, and three were damaged. Also in the area were seven drilling rigs that were not damaged.

When the Weather Bureau advises that a hurricane or serious tropical storm is imminent, all oil and gas facilities in or adjacent to the path of the storm are evacuated. Upon evacuation,

---

1/ Corps of Engineers, Report on Hurricane Camille, Report No. 1338, 1970, U.S. Army Engineer District, New Orleans, Louisiana.

all surface equipment and wellhead controls are shut-in. In addition, blank tubing plugs are set in as many wells as possible to further reduce the possibility of pollution in the event the well is damaged. These tubing plugs form a seal against fluid flow.

Thus, it can be seen from accident records and industry performance that pollution due to hurricanes has resulted not from damaged and wild wells, but from platforms where the product transportation mode has been by barge. Because it is anticipated that only a relatively small amount, if any, of oil will be barged (i.e., only 2% of all OCS oil is barged and almost all new production is conveyed by pipeline) we do not feel there will be any substantial spills as a result of hurricanes.

Based on the total oil and condensate produced during the years 1964-April 1974, (2.9 billion bbl.), we note that 11,900 bbl. represents a spillage rate of 0.00041% due to hurricane damage. Projecting this rate to the maximum annual production rate projected for the proposed sale, we note that almost 187 bbl. per year could be spilled during hurricanes. This projection assumes the incidence of hurricanes to be uniform through the Gulf of Mexico OCS (i.e., about 1-3 per year). The maximum spillage from a single hurricane would depend on the extent of barging (and therefore,

the number of platforms with large storage tanks) and volume of oil present in the tanks. With only one incident on record, no generalization can be made concerning the maximum spillage during a single hurricane.

(5) Accidental Spills from Overflow, Malfunction, Rupture or Failure of Platform Piping Valve or Vessel

This category of spills is essentially an extension of the "minor" spills, i.e., it includes those spills of the same origin as minor spills but consists of those that involved the loss of 50 bbl. or more before the condition was corrected. Accident records indicate a total of 12 such spills through April 1974. Total spillage was 1,558 bbl. or an average of 130 bbl. per spill.

Assuming conditions leading to such spills will remain the same in the future, the spillage rate of 1,558 bbl. to 2.9 billion bbl. produced is 0.00005%. Projecting this to the maximum level of production for this proposal (45,625,000 bbl./yr.), the projected spillage is a little less than 23 bbl. per year.

(6) Accidental Spills Due to Ships Colliding With Platforms

To be considered here are spills that occur from platforms resulting from a collision by a commercial vessel. Spills of OCS produced oil from tankers and barges is considered in the next section (7). Consideration of vessel damage, platform damage, loss of life, and economic loss is included in subsection d., below.

In April of 1964, a freighter off central Louisiana struck and damaged a platform, resulting in a fire and the loss of 2,560 bbl. of oil into the sea. Accident records do not indicate a blowing well, therefore, the source of oil was probably a large storage tank, used to accumulate production for barge transshipment.

Again using data for spillage vs. production, we estimate that 41 bbl. per year could be spilled from accidents of this type. The maximum size of a single accident is difficult to predict. A history of one accident is obviously insufficient for generalization.

(7) Tanker and Tank Barge Accidents and Operations

Almost 36.5 million barrels of oil are released annually to the marine environment as a result of accidents, carelessness or mismanagement (Charter, et. al., 1973). Figure 15 shows the percentage of the total outflow from various

polluting sources for the entire world oceans (Porricelli and Keith, 1973). Figure 16 further breaks down the data on 269 polluting incidents which occurred in 1969 and 1970 involving tankers. This data puts into perspective the amount of pollution from tank barges and tankers, and shows, to some extent, the amount of spilled oil attributable to various types of tanker accidents.

In 1971, the United States tanker fleet carried 5.5%, or 71 million metric tons, of all waterborne petroleum in the world. In the same year, they were responsible for discharge of 55,000 tons of oil into the marine environment. Combining tankers and tank barge spillage, "....it is estimated that 0.003% of the oil volume handled is spilled." (Porricelli, et al., 1971).

This figure can be used to calculate the potential amount of oil from this proposed lease sale that will reach the marine environment as a result of tanker and tank barge movement of oil.

Figure 15. Sources of Oil Pollution to the Oceans from Porricelli and Keith, 1973)

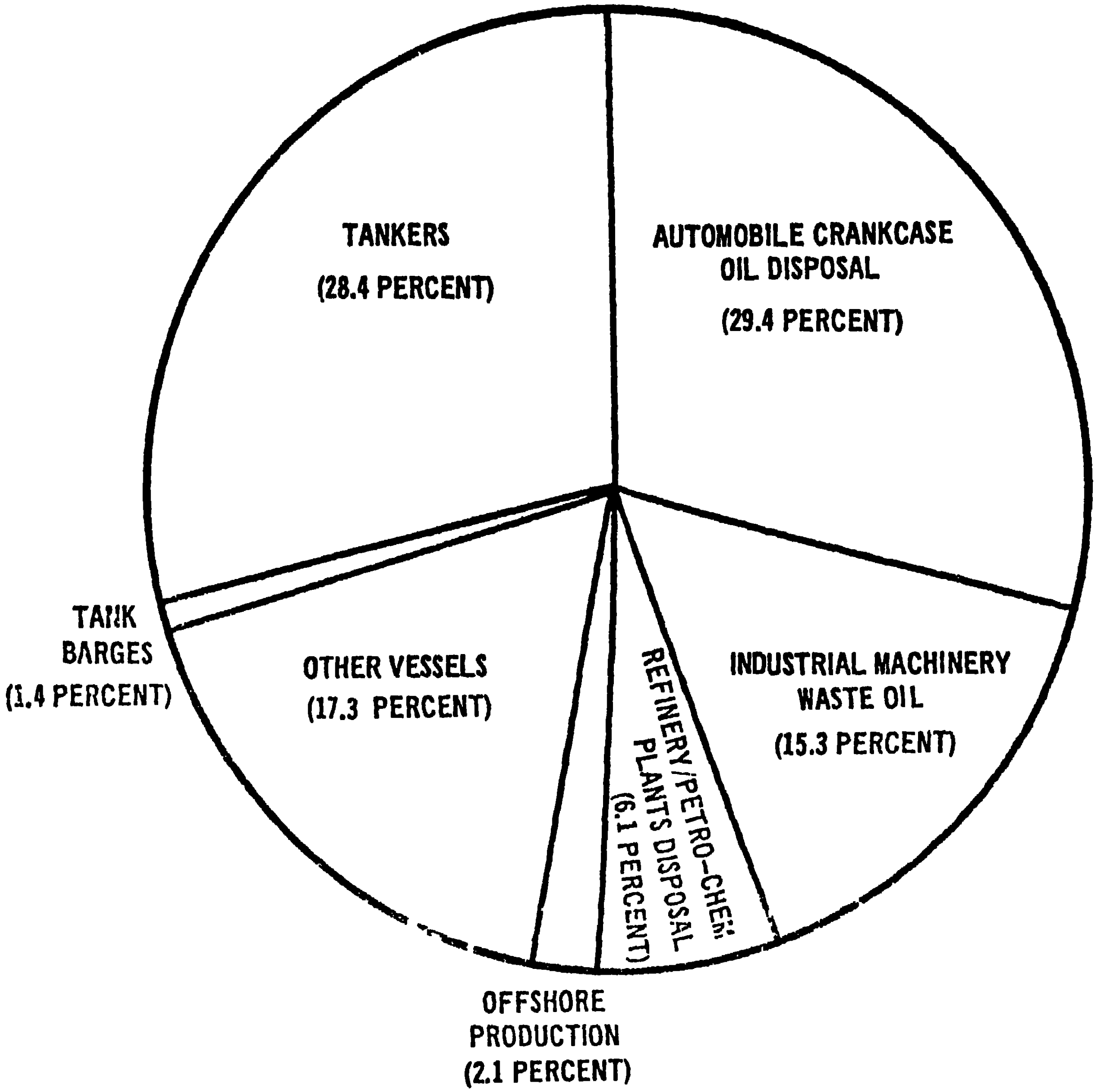
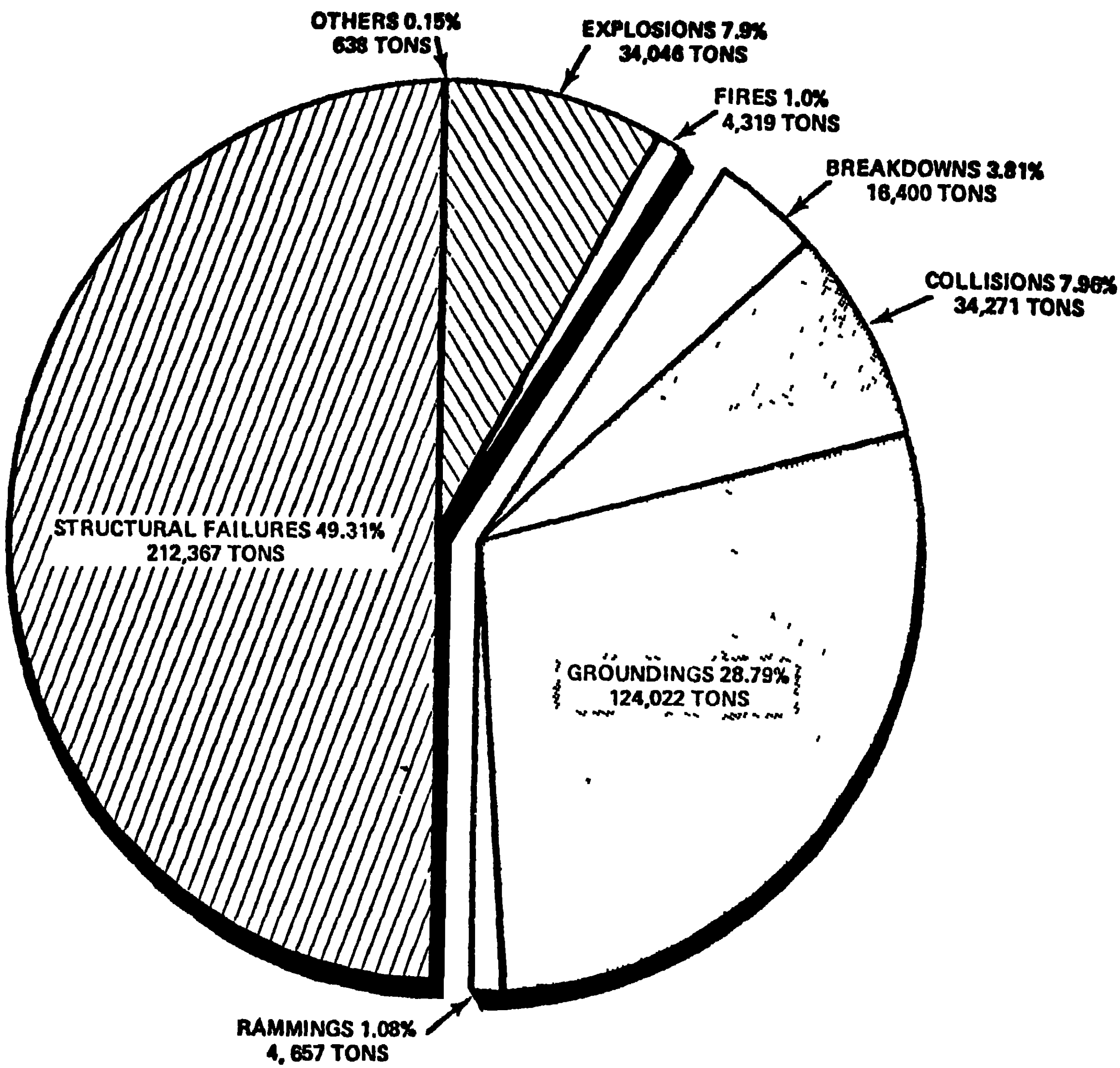


Figure 16. 1969-1970 Tanker Polluting Incidents, Percentage Oil Outflow by Type of Accident from Porricelli and Keith, 1973.



(8) Other Spills of 50 Barrels or More

Just two recorded spills remain which do not fit into the categories used in the preceding subsections.

In June, 1965, during well abandonment and platform removal, a well break resulted in a spill of 500 bbl. We hesitate to predict that such an accident will happen again. OCS Operating Order No. 3, issued in 1969, requires that a redundant series of bridging devices, weighted muds, and cement plugs be placed in any well or drill hole prior to abandonment. We believe that well or hole abandonment performed in this manner provides an ample margin of protection against any possible communication between subsurface oil bearing formations and the atmosphere.

In two similar incidents, occurring in July, 1971 and January, 1973, damage to oil storage barges caused spills of 7,100 bbl. of oil into the sea before the cargo could be offloaded onto another barge.

c. Minor Spills

The requirement for reporting minor spills (less than 50 bbl.) and slicks of unknown origin was put into effect in 1969. From 1970, the first full year of minor spill records, to the present, the number of minor spills reported has remained almost constant, but the total volume of spills has decreased each year. The following table (Table 6), furnished by the Geological Survey, lists annual totals of minor spills by number, volume, and source, and also lists the number of slicks sighted.

Table 6.

MINOR OIL SPILLS

Year	Total Number Reported	Source by Number Drilling	Source by Number Pro.& Trans.	Total Volume (Bbl.)	No. Oil Slicks Sighted, Not Ident. by Source
1970	1,200	4	1,196	2,597	745
1971	1,250	13	1,237	2,414	878
1972	1,158	13	1,145	1,812	606
1973	1,181		1,171	1,857	722
1974 1st qtr.	213	3	210	165	143

Oil slicks from unidentified sources are not positively related to offshore drilling, transportation, or production. There is evidence of natural oil seepage in the Gulf of Mexico, first recorded in 1906, long before oil development activities were initiated, and seepage still persists in oil prone areas. It is possible that these natural seeps could be the source of some slicks classified as being from an "unidentified source". Other possibilities are ships bilges and tanker cleanings.

We are optimistic about the industry's performance in cleaning up its routine operations and decreasing the amount of chronic spillage. The trend becomes obvious when total minor spills in barrels per month are plotted against time, as has been done in Figure 17. The smooth curve represents a constant percentage (2.57%/mo.) decline based on the plotted data. During the period 1970-73 total oil and condensate production varied by less than 13% whereas the constant percentage decline curve represents a decrease in minor spill volume of 60% over the same period.

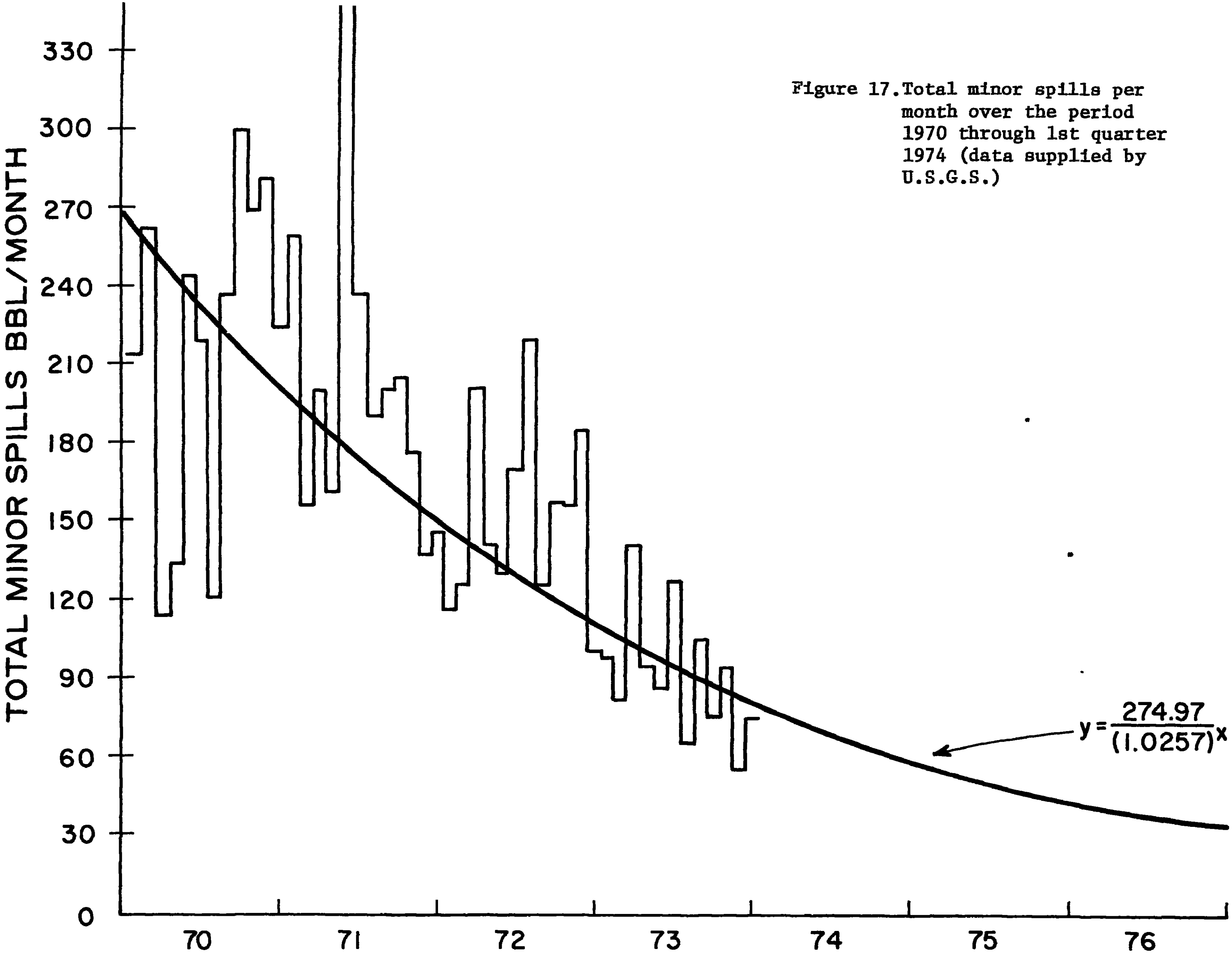


Figure 17. Total minor spills per month over the period 1970 through 1st quarter 1974 (data supplied by U.S.G.S.)

If a total of 8,680 bbl. of petroleum liquids were spilled during the years 1970-April, 74, and 1,507,964,609 bbl. were produced during the same period, the spillage rate was 0.000576%. Projecting this rate to the present proposal, where maximum production is estimated at 45,625,000 bbl/yr., it seems valid to project a maximum minor spill level at about 262 bbl./yr. If the downward trend of minor spill volumes, as shown in Fig. 17, continues, the figure will be significantly smaller. By definition, the maximum size of a single minor spill, of course, is less than 50 bbl.

d. <u>Collisions Resulting From Conflict Between Ship Navigation and Offshore Structures</u>

During the period July 1, 1962 through June 30, 1971, the Coast Guard recorded 24 incidents of collisions between vessels and fixed platforms. Total damages were estimated to be about $0.4 million to vessels and $3.4 million to the structures. Only four injuries and no deaths were reported. Of these, eight accidents involved vessels of over 1,000 gross tons. These eight accidents accounted for $87 thousand of vessel damage (only four vessels reported damage) and over $3.2 million damage to platforms and no injuries or deaths reported. Five of these accidents occurred at night (three within two hours of midnight) and two during day-light. All of the eight major accidents occurred outside established shipping fairways and anchorage areas and only three were less than five miles from these established areas. At least five of the accidents involved foreign flag vessels. The worst of these eight accidents occurred in 1967

when a 11,600 ton foreign flag cargo vessel collided with a platform in Ship Shoal Area Block 214 at 1:30 a.m. during heavy rain, poor visibility, 45 knot winds and 15-20 foot seas. The vessel escaped with damages estimated at $12,000 but damages to the platforms were of the order of $1.1 million or 1/3 of the total damages in all eight accidents. Nearly one year following this collision a blowout of gas and condensate occurred on this platform. There was a minimal amount of oil spilled because the well was producing gas.

The remaining 16 incidents of collision between vessels (less than 1,000 gross tons) and platforms caused more damage ($290 thousand) to the vessel than to the platforms ($100 thousand). Causes were assigned as 2-weather, 8-vessels and 6-platforms; the platforms causes were further defined as 3-equipment failures, 2-insufficient or improper lighting and 1-improper maintenance.

During the time period 1957-1971, the Geological Survey recorded only one significant spill of oil, 2,560 bbl., associated with ship-platform collisions, as discussed in subsection b. (6), above.

e. Accidental Deaths and Injuries on Oil Industry Structures and Vessels

Information supplied by the U.S. Coast Guard reveals that a total of 100 individuals were killed as a result of accidents involving construction, supply, and drilling vessels, workboats, mobile drill rigs, and artificial islands in the Gulf of Mexico and

adjacent navigable inland waters during the period 1964-1973. Of these 100 deaths, approximately 66 occurred in water approximately equal to the Federal OCS area. Table 7 on the following page, provided by the Coast Guard, shows these casualties by source and year. These figures do not include deaths resulting from accidents in which no vessel or rig damage occurred (i.e., persons falling, or knocked overboard, crushed by drilling equipment, etc.). Since complete data is not available for the years 1964-1966, only the data from 1967-73 will be used as a basis for the following predictions.

Deaths due to offshore oil and gas operations involving vessel damage totalled 68 from 1967-73. Of these, 41 took place in international waters and 27 in inland waters. In addition, 35 persons were killed in oil operations in the Gulf of Mexico (both inland and international) with no casualty to the vessel being involved. Using the 41:27 ratio based on deaths involving vessel damage, we estimate that 21 of the 35 deaths not involving vessel damage will occur in international waters. This gives a new total of 62 deaths occurring in international waters from causes related to OCS oil and gas operations. Based on this information, approximately 9 deaths per year may be expected in the Gulf of Mexico as a result of offshore industry activity in OCS waters.

Table 7. Total Deaths Reported as Resulting from Vessel Casualty

	Inland Waters Gulf of Mexico										Gulf of Mexico									
	Fiscal Years																			
	64	65	66	67	68	69	70	71	72	73	64	65	66	67	68	69	70	71	72	73
Mobile Drill Rigs and Artificial Islands	No info		-	7	-	12	-	-	-	-	No info		-	-	2	1	7	14	6	1
Oil Industry Supply Vessels and Workboats	-	-	-	-	-	-	3	2	-	-	-	-	2	-	-	-	-	4	-	-
Oil Industry Construction And Drilling Vessels	4	1	2	1	-	2	-	-	-	-	22	1	-	1	-	-	2	3	-	-
Sub Total	4	1	2	8	-	14	3	2	0	0	22	1	2	1	2	1	9	21	6	1

Total 101

Below is listed a summary of injuries reported to the Office of Workmen's Compensation Programs under the Outer Continental Shelf Lands Act by district. 1/ The years are recorded as fiscal years (Table 8).

1/ U.S. Dept. of Labor.

Table 8. Total Injuries Reported Under the OCS Lands Act

ALL DISTRICTS

		Cases Reported	
Fiscal Year	Non Fatal	Fatal	Total
1968	3,583	28	3,611
1969	3,395	25	3,420
1970	3,261	21	3,282
1971	2,822	32	2,854
1972	1,975	14	1,989
1973	2,307	21	2,328

DISTRICT 7 - NEW ORLEANS

1968	2,772	25	2,797
1969	2,578	17	2,595
1970	2,777	12	2,789
1971	2,664	30	2,694
1972	1,788	11	1,799
1973	2,214	21	2,235

3. Impacts Which Can Be Minimized or Avoided by Regulations and Safe Operating Practices

A more thorough discussion of regulations and operating orders is presented in section V, "Mitigating Measures Included in the Proposed Action".

4. Summary of Impacts

The preceeding sections describe the source and amount of both intentional and unintentional discharges which will pollute the sea and ocean floor if this proposed lease sale is held. It is the intent of this section to summarize all projected polluting discharges in tabular form (Table 9). Two features should be pointed out prior to consideration of the tabular values.

(1) All pollution sources will not be present throughout the life of the leases; e.g., exploratory drilling will be completed within 4 years of leasing, developmental drilling, within 7, and production will not begin until the third. "Deep" water tracts may take slightly longer to reach the production phase. The reader is reminded of the timetable and discussion in Sec. III.A.5.

(2) The text of the preceding sections contains estimates of maximum pollution anticipated based on the maximum number of wells and amount of production. The table included here shows a range of pollution anticipated, based on the range of production predicted by the Geological Survey (70,000-125,000 bbl. of oil per day or 26 million-46.5 million bbl. per year).

GPO 875-501

Table 9. POLLUTION FROM DEVELOPMENT AND OPERATIONS OF OIL AND GAS LEASES OCS SALE #.36

Pollution Source	Pollutant	Duration	No. Incidents		Volumes		Units
			Low	High	Low	High	
Well Drilling	Drill Cuttings	Exploratory - 0-4th year Development 3-7th year	700 (wells)	900	630,000	810,000	tons
Well Drilling	Mud Chemicals	Same as above	700 (wells)	900	140,000	180,000	tons
Total drill cuttings and mud chemicals discharged into sea					770,000	990,000	tons
Produced Formation Water	Brine/Oil	3rd yr - life				603,000 1/	bbl/day
Pipeline Leaks	Oil	3rd yr - life	0	3/yr	0	776 2/	bbl/yr
Blowouts (Drilling)	Oil	0 - 7th yr	0	1	0	3/	
Platform Fires & Explosions	Oil	3rd yr - life	0	1/yr	0	1,323	bbl/yr
Hurricane Damage	Oil	3rd yr - life	1/yr	3/yr	0	187	bbl/yr
Equipment Failure/ Human Error	Oil	3rd yr - life	2/yr	5/yr	0	23	bbl/yr
Ship Collision	Oil	Life	0	1/yr	0	41	bbl/yr
Minor Spill (50 bbl)	Oil	Life	100/yr	150/yr	65	262	bbl/yr
Maximum amount oil which could be spilled into sea						2,612 4/	

1/ Total for all current Louisiana OCS operations - approximately 305,000 bbl/day transported to shore.

2/ This figure includes data from 1970-April, 1974. If we include all incidents from 1964-1974, then the projection would change to 3,148 bbl. per year.

3/ Too many factors involved to make a meaningful projection. No "annual" volumes concerned.

4/ Does not include oil associated with formation water; represents peak production, not development or declining years.

IV. ENVIRONMENTAL IMPACTS OF THE PROPOSED SALE

A. Impact on the Living Component of the Environment

An Introduction

OIL SPILLS

The most severe impacts on the communities of the marine and coastal ecosystems of the eastern Gulf of Mexico will be those resulting from spilled oil. It is important at the start, however, to point out that predictions of effects at the community, even population, level have no firm basis in the existing literature. No studies aimed at determining the effect of spilled crude oil at the community level have as yet been accomplished in the Gulf of Mexico. Studies which encompass effects at the community level are unfortunately far removed geographically and not closely related to conditions in the Gulf. These latter studies include the commendable efforts of the scientists at Woods Hole in their study of the spill at West Falmouth, but the material spilled there was No. 2 fuel oil, generally conceded to be far more toxic than most crude oils. Also included are the studies at Santa Barbara and at Milford Haven and Cornwall, England, which addressed various aspects of high energy beaches, natural beach erosion, rocky intertidal zones, large tidal ranges, natural oil seeps, pesticides and large quantities of emulsifiers. Few of the conditions of these studies are exactly duplicated in the Gulf of Mexico.

The larger proportion of studies on oil pollution has been devoted to effects on small biotic groups or individual species, involving either accidental spills, controlled oilings, or laboratory aquarium studies, and the results are applicable at the cellular or organismic level.

Thus, predictions of impact must be based on diverse and mostly unrelated studies, few of which are devoted to the Gulf of Mexico; conclusions, where made, must be regarded as tentative.

In preparation of the Georges Bank Petroleum Study, MIT's Offshore Oil Task Group (1973) 1/ identified several pathways by which crude oils can exert a damaging effect on plants and animals.

a) any disruption at or below cellular level is considered to be cellular effect;

b) any disruption above the cellular level dealing with biochemical processes is considered to be physiological effect;

c) any disruption of instinctive and/or voluntary control is considered to be a behavioral effect.

They then defined five responses which are elicited by these three types of effects:

1/ The Georges Bank Petroleum Study. Offshore Oil Task Group, Massachusetts Institute of Technology. Sea Grant Project Office, Report No. MITSG 73-5, 1 Feb. 1973.

(1) lethal toxicity,

(2) sub-lethal disruption of physiological or behavioral activities,

(3) the effects of a direct coating by oil,

(4) incorporation of hydrocarbons in organisms which cause tainting and/or accumulation of hydrocarbons in food chains, and

(5) changes in biological habitats.

We have taken these responses and applied them to three broad categories of spills and the ecosystems they effect in Table 1.

PIPELINE BURIAL, DRILLING MUD AND CUTTING DISCHARGES

No attempt has even been made to determine the effects of these operations on the marine and coastal ecosystems in the Gulf of Mexico, or, to our knowledge, anywhere in the world. This dearth of information will hopefully be remedied by future studies and the results of several promising current studies.

It can be assumed that the effects of pipeline burial in offshore areas and wetlands will be qualitatively similar to those ascribed to channel dredging, but not as severe because

Table 1. Ecosystems Affected by Various Aspects of Oil Spills

urce	Lethal Toxicity	Sublethal Effects	Coating With Weathered Oil	Incorporation of Hydrocarbons into Food Webs	Changes in Habitat
ssive Oil Spill	Open Gulf Shoreline Estuary/ Wetland	Open Gulf Shoreline Estuary/ Wetland	Shoreline Estuary/ Wetland	Open Gulf Shoreline Estuary/ Wetland	Shoreline Estuary/ Wetland
Small Oil Spill	Shoreline Estuary/ Wetland	Shoreline Estuary/ Wetland	Estuary/ Wetland	Estuary/ Wetland	
hronic is- harges and Minor Spills	Shoreline Estuary/ Wetland	Open Gulf Shoreline Estuary/ Wetland	Shoreline Estuary/ Wetland	Shoreline Estuary/ Wetland	Shoreline Estuary/ Wetland

xplanation of Terms:

assive Oil Spill: Several hundreds to thousands of barrels
mall Oil Spill: Fifty to a few hundred barrels
hronic Discharges and Minor Spills: Amounts small but very frequent or continuous
ethal Toxicity: Interrupts physiological processes at cellular or organ level
ublethal Effects: Adverse effects on physiology of growth and reproduction and on instinctive and voluntary behavior
oating with Weathered Oil: Large patches of tarry material which has already lost much of its toxicity due to biochemical oxidation, vaporization
hanges in Habitat: Lasting for several years, longer than the spill/ clean-up period.
Shoreline: Intertidal to exposed beach; not including estuaries, bordering wetlands.

the digging of a pipeline canal, or burial of a pipeline is a one-time event, whereas channel dredging is more or less continuous.

It is tentatively assumed that the effects of drilling muds and cuttings discharges are also related to those of dredging, specifically, turbidity and smothering. Of further note is the presence of chromium in many marine drilling muds as the organic complex, (ferro)chrome lignosulfonate. Overboard loss or discharge of drilling fluids would introduce some of this chromium into the marine environment. On a weight basis, this element is present in unweighted commercial lignosulfonate drilling mud components at a concentration of about 12 ppt. Required sea water additions to the mud concentrate reduce this value to less than 4 ppt. -- the approximate concentration of chromium in discharged drilling mud. In addition, dilution/disperson effects associated with overboard discharge into Gulf waters would be considerable.

Although data relating to toxicities of organic compounds containing chromium are scarce, recent work suggests that chrome lignosulfonate, in moderate to strong dilution, is relatively harmless. While readily soluble in sea water, the compound apparently dissociates very little. If inorganic chromate is also present in the drilling mud, however, oxidation of the chrome lignosulfonate occurs, evolving a new organic

chromium complex (Skelly and Dieball, 1970).[1] The nature of this new phase is not well understood.

Jessen and Johnson (1963)[2] discuss physical adsorption and ion exchange relations between chrome lignosulfonate and clay components of drilling muds. Their work indicates a strong tendency towards adsorption of all chrome species present in the muds tested. Ion exchange occurred predominately in the high-sodium bentonite clay types. Both transfer mechanisms effect the removal of chrome components from the water column with subsequent deposition as clay sediment. Once on the sea floor, chrome lignosulfonate is fairly resistant to biodegradation, however, certain benthic invertebrates are known to concentrate trace amounts of various heavy metals over extended time. The possible role of drilling mud chromium additives in this phenomenon should not be ignored. Recent industry tendencies towards maximum recovery of chemical additives will minimize any potential hazard to life species while relevant experimental data accumulates.

In general the effects of pipeline burial and drilling mud and cutting discharges are:

a) dredging nearshore areas where land pollution has occurred for many years, numerous pollutants will be resuspended in the water column. These may include organic matter which

---

1/ Skelly, W.G. and D.E. Dieball, 1970. Behavior of chromate in drilling fluids containing chrome lignosulphonate. Soc. Petr. Eng. Jour., 10:140-144.

2/ Jessen, F.W. and C.A. Johnson, 1963. The mechanism of adsorption of lignosulfonates on clay suspensions. Soc. Petr. Eng. Jour. 3:267-273.

will increase BOD and decrease dissolved oxygen, toxic heavy metals and pesticides which may exert toxic effects before gradually being reincorporated into the sediments.

b) dredging in areas of hard bottoms, where biotic communities have evolved to take advantage of such conditions and are adapted for attachment to a hard substrate (sponges, soft and hard corals, seaweeds, sessile molluscs), will eliminate suitable sites for attachment in the path of the operation. These effects will be neither permanent or last until the substrate can become compacted again, a process involving at least several years.

c) both pipeline burial and mud/cutting discharges will produce a smothering effect on the burrowing and attached benthos where the material gradually settles as a layer of significant thickness.

d) increased turbidity will occur at all marine sites where pipeline burial and mud/cutting discharges takes place. The fine particles causing the turbidity can clog the respiratory organs and filter-feeding mechanisms of many marine animals.

e) pipeline burial in coastal wetlands and uplands will displace many species of wildlife during operations due to noise pollution and the physical presence of construction machinery. This disruption will terminate as soon as

construction is completed if the canal can be adequately backfilled. The effects of pipeline burial in wetlands can have a substantial impact of one to several years duration through devegetation and disruption of substrate. If a "floatation" canal must be used, there would be a virtually permanent open canal through the marsh.

OTHER IMPACTS

Still significant, but probably less environmentally damaging impacts result from the discharge of produced formation waters into the sea and onshore habitat removal by pipeline terminals and ancillary facilities.

B. Impact on Biota of the Open Gulf

Impacts in the open Gulf ecosystem will result from accidental loss of debris, discharge of drill cuttings, sand, drilling fluids, the burial of pipelines, and the accidental spillage of oil or other toxic materials. It must be recognized at the outset that oil spills probably represent the most severe threat to biota, but various fractions of crude oil present greater or lesser threats. The natural (chemical, physical, and bacteriological) degradation of crude oil is a complex and not well understood process. Additional complexities such as local concentrations of various hydrocarbon fractions, and the different effects of these concentrations on different species are concomitant with the degradation process. Much of our knowledge of these factors has been obtained through laboratory studies, poor analogs for the natural environment. Available information will be presented in the appropriate sections following.

1. Impact on Pelagic Marine Life

Pelagic marine life includes a broad spectrum of organisms from all trophic levels and includes the phytoplankton, zooplankton, nekton and demersals (shrimp, fish, squid, and marine mammals), and pelagic seabirds.

a. Impact on the Plankton

Impacts that may be anticipated to have an effect on plankton will result from accidental spills of oil (and associated

use of emulsifiers) and other toxic materials, discharge of drilling fluids and formation waters, and burial of pipelines.

After an oil spill has occurred, that which has not evaporated, been carried ashore, or cleaned up will float at the surface for a time and eventually be dispersed as minute droplets in the water. In addition, certain components of crude oil are slightly soluble in seawater. In each of these three phases (floating, droplets, solute) the oil has the opportunity to damage marine organisms and/or enter the marine food web. The organisms most immediately and drastically affected are those which are found in close proximity to the sea surface.

Spooner (1969) notes that plankton collections following Torrey Canyon showed damage to minute plant cells of the order Prasinophyceae which float at the surface. A high proportion of pilchard eggs, which also float, were dead and there was a local shortage of pilchard larvae. She is unsure whether this damage was done by oil alone or by oil and the emulsifiers which had been used to disperse the oil. According to Mironov (1971), cited in Ketchum 1973, cell division in phytoplankton was delayed or inhibited by crude oil concentrations ranging from 0.001 to 1000 ppm.

Hufford (1971) notes laboratory studies which indicate that oil can affect phytoplankton after several days exposure. He cites laboratory experiments in which oil products in sea water inhibit cellular division and cause death in phytoplankton. Apparently, cellular membranes were damaged by the penetration of hydrocarbons and this led to the extrusion of the cellular contents. During a study of the effects of the Santa Barbara spill, however, Oguri and Kanter (1971) found no conclusive evidence of a decrease in phytoplankton community productivity that could be attributed directly to the oil spill. Individual experiments indicated, however, that the use of dispersants may have resulted in marked reductions in productivity. They theorized that the longevity of any such effect would depend on the currents and rate of dilution, as well as the type and quality of the dispersant. No evidence was found in the literature that spilled oil enters marine food chains via adsorption or absorption by phytoplankton and subsequent ingestion by grazing herbivores.

The floating seaweed Sargassum and its associated community would be damaged by floating oil. In mature states, this seaweed, along with broken blades of seagrasses, can form large floating mats, patches or long windrows. This is a very rich community including

a large aufwuchs (living attached to, or gliding upon) component, and a rich plankton component. In addition, many juveniles of fish, squid, and other nektonic forms are associated with the floating masses (LaRoe, 1972). It is conceivable that oiling of the sargassum would cause it to adhere and form tight mats or clumps and would result in complete destruction of the community.

Little information has been found concerning the effect of crude oil on the zooplankton. Hufford (1971) cites one experiment which showed accelerated death of zooplankton exposed to diesel oil (0.1% for 5 to 60 minutes) as compared to non-exposed zooplankton. Mironov (1971) as cited in Ketchum, 1973, states that some copepodes are sensitive to 1 ppm suspension of fresh or weathered crude oil and diesel fuel. Zooplankton have been observed to ingest spilled Bunker C oil particles, however, with no apparent effect. Members of the Operation Oil Task Force (1970), studying the effects of spilled Bunker C from the tanker Arrow in Chedubucto Bay, Nova Scotia, observed that many copepods in the area had apparently ingested small oil partilces and 2.4% Bunker C was found in the feces of one species. They noted that animals containing smaller oil particles voided these within 24 hours and showed no signs of distress. That they continue normal activities apparent harm is quite important to the marine food web, because they can be eaten by small fishes and filter-feeding organisms

while carrying the oil in their guts. The fish and filter-feeders may in turn be eaten by larger predatory animals, establishing the potential for a classic example of biological magnification of a potentially harmful or toxic compound. A similar effect could be expected if other toxic materials such as diesel fuel, solvents, or heat exchanger fluids were spilled during handling or as a result of platform damage.

The preceding discussion includes only the results of massive, infrequent spills. However, statistical evidence exists (see section III.A.) that small spills of fractions of a barrel to 50 barrels occur on the order of a thousand times per year in the Gulf of Mexico. The problem of determining potential impact from chronic, low-level spillage is difficult. Virtually none of the reports which we were able to obtain of scientific investigations on oil spillage, addressed the effects of low-level, continuous spillage in offshore water. It is difficult to assess or predict potential damage to one group of organisms, i.e., plankton, but it seems appropriate to discuss the problem at this point. A few scientists have offered cautious speculation. A more pessimistic view is taken by Blumer (1969) who has stated: "...we are rather ignorant about long-term and low-level effects of crude oil pollution. I fear that these may well be far more serious and long-lasting than the more obvious short-term effects." Blumer (ibid) then points out that hydrocarbons are taken up into the

food chain, and through the process of biological magnification can become concentrated in marine species used by man for food. He states "One consequence will be the incorporation into food of materials which produce an undesirable flavor. A far more serious effect is the potential accumulation in human food of long-term poisons derived from crude oil, for instance of carcinogenic compounds." Blumer also cautions that low-level pollution may damage the marine environment by masking natural chemical sex attractants, interfering with chemical food sensing and enemy replusion. He states, "There is good reason to believe that pollution interferes with these processes in two ways: by blocking the taste receptors and by mimicking for natural stimuli;..."

A somewhat less pessimistic view is taken by St. Amant (1972). In offshore areas, where chronic spills could result from leaking vessels and plumbing, and discharge of oil-contaminated, produced brine waters, St. Amant views the problem as follows:

> "Chronic pollution from offshore production sites represents an unknown factor. Daily drips and loss of small amounts of oil or other chemicals overboard do not appear to generate ecological problems because of the relative immensity of the water column. Whether such sublethal pollution will eventually accumulate and cause environmental degradation is yet to be determined. Because of this unknown factor, significant effort should be made to prevent low-level pollution."

A still less pessimistic view is taken by Oppenheimer. 1/ He notes that hydrocarbons have been a part of the natural environment since

---

1/ Oral and written testimony given by Dr. Carl Oppenheimer of Univ. Texas Marine Station at the OCS Public Hearing on a proposed oil and gas lease sale offshore Louisiana. August 23, 1972. New Orleans, Louisiana.

life began. Also, he states that, "...except for the commercial concentrations of oil in our geosphere, no recognizable concentration of specific molecules have persisted in the aquatic environment other than tar balls, as microorganisms are ubiquitous in their role in mineralizations or recycling of the hydrocarbons in natural environments."

Oppenheimer continues:

> "There is _a priori_ evidence that hydrocarbons may in some areas be significant as a nutrient source for living organisms. It may not be surprising when one looks at the pathway of hydrocarbon degradation. A first step of degradation is the formation of fatty acids which is a good source of food for marine organisms. It is interesting to note that the fish catch in the oil producing areas of Louisiana has increased materially during the past 30 years. Fishing effort in the Gulf remained somewhat constant over the last 10 years with 10,000 small boats and 3,500 vessels operating... Logic tells us that fish must be present if they are being caught. This fish catch increase is in an area where nearly 3 billion barrels of oil have been produced over the last 30 years. I find that total fish catch, as it represents the top of the food chain, can be a good indicator for the state of the environment."

In his summary, Oppenheimer notes, "...there (is) no conclusive evidence of long-term adverse oil effect on the living populations...."

It is our conclusion, based on past performance (see statistics, section III.B.) that sooner or later a major spill will result if this proposal is implemented. We are certain that thousands of minor spills will occur. As to the effects of a major spill on plankton, and the entire ecosystem as well, we endorse the conclusions of Dr. James I. Jones, Research Coordinator of the Coastal Coordinating Council, Florida Department of Natural Resources. 1/ He stated that:

1/ Letter, through State of Florida, Department of Natural Resources, dated June 22, 1973.

"The catastrophic major oil spill is the single most visible, and therefore to a degree, most controversial of any aspect of petroleum production and transfer. While there is no question that a major spill does indeed cause a massive destruction to both flora and fauna, as well as the environment itself, these effects are of a temporary nature in most respects. The natural recovery capability of a healthy ecosystem is such that the massive mortality and destruction attendant with a major spill will allow a recovery of the ecosystem, with some alteration, within a relatively few years. In those areas where the ecosystem is already stressed, however, as is the case in many areas within the coastal zone, a single catastrophic spill could well create effects that are far beyond the natural recuperative powers of the ecosystem."

We believe that the plankton and other populations of the Louisiana Outer Continental Shelf ecosystem will be able to absorb the impact of a major oil spill and recover fairly rapidly. Our greatest concern is for coastal areas and estuaries, which are discussed later. It is not likely that significant amounts of oil spilled from platforms would reach most coastal areas, because of the distance from shore, prevailing winds and currents, and clean-up operations. The greatest possibility for a coastal and shallow water oiling is from tracts in the South Marsh Island-North Addition, Eugene Island, Ship Shoal, South Pelto, West Delta, South Pass, South Pass-South & East Addition, Main Pass, Main Pass-South & East Addition, and Mobile South No. 2.

The regular discharge of formation waters, "oil field brines", could have a severe local impact on the plankton. It has been conjectured that the brines also could serve as a "fertilizer" in shallow seas which might trigger a red tide.

Although formation water is put through a polishing facility and has all but traces of entrained oil removed, it may contain a heavy con-

centration of dissolved salts 1/ and is devoid of dissolved oxygen. It could be anticipated that the release of this water would result in a plume trailing away from the point of discharge in the direction of the current with a core perhaps a few feet in diameter and tens of feet in length. This plume would probably be harmful or lethal to the plankton. Physiological stress would probably result from an osmotic imbalance (cells losing water to surrounding brine) and low dissolved oxygen. Beyond the zone of stress, however, Mackin (1971) has actually noted a zone of stimulation or fertilization during a study of brine discharge in Galveston Bay.

Red tide outbreaks have occurred in several coastal areas of the Gulf, notably the west coast of Florida and east Texas, but have not been reported in Louisiana waters. Ingle and Martin (1971) have correlated red tide occurrences in Florida with iron compounds of various types and concentrations. Formation waters contain iron in the range of 15 to 153 mg/l, but the amount of iron postulated by Ingle and Martin as necessary to trigger a red tide could not be supplied by oil field brines. If the possibility of red tides exist in Louisiana waters, we do not believe that an occurrence will be caused as a result of this proposed sale and subsequent operations. Further, we do not believe that other constituents of brines could be responsible,

---

1/ An average of 141,473 mg/l was found in the examination of over 80 examples of formation water taken from South Louisiana and the OCS. This value may be compared to the world average of 35,000 mg/l for natural seawater.

because they are not now known to be limiting factors in red tide blooms.

The remaining impacts suffered by the plankton will be localized, and are all related to increased turbidity. These impacts are brought on by the discharge of drilling fluids and drill cuttings, and the jetting of sediments during underwater pipeline burial. The turbidity conditions resulting from these operations are seen as a visible plume in the direction of local currents and usually disappears within a few yards to a mile from the source. The effect of this turbidity on a given parcel of water is of short duration, lasting on the order of a few hours at the most. The physiological effect is to depress photosynthesis by obstructing the penetration of sunlight. It is our conclusion that the effect of increased turbidity would be immeasurably small at more than a few feet from the point of discharge.

Of particular interest are the planktonic larvae of various benthic invertebrates. These meroplankters (planktonic for part of life cycle) are generally considered to be most sensitive to environmental stress and predation while in the water column. Pelagic larvae are the primary means by which benthic invertebrates distribute themselves over wide geographic areas. Based on the high reproductive potential and numbers of larvae released by these animals, we feel that, while there may be a locally adverse effect, distributional and survival powers will not be significantly affected.

b. Impact on the Nekton

Nekton, by definition, include all marine animals which are active swimmers and are able to migrate freely over considerable distances. This motility, combined with irritation sensing ability and natural escape and avoidance behavior, enable them to avoid localized adverse conditions.

Therefore, the only significant impact on the nekton would be as a result of a massive oil spill.

No information has been found on the effect of spilled oil on members of the nekton other than fish. Hufford (1971) cites several early studies which show that crude and bunker oils harmed or killed fish eggs in laboratory experiments. He also cites Mironov (1970) who found that oil affects fish respiration by clogging gills and damaging gill tissue. At the behavioral level, Nelson-Smith (1971) has stated that fish seem to avoid contaminated areas. While this has survival value for the fish, the contaminated areas then constitute unusable habitat. A more common (and easier) approach to studying the effects of oil on fish is to expose them to various amounts of oil in a laboratory aquarium (e.g., Spears, 1970) but this is not of great value in assessing the impact of spilled oil in the ocean because of the vast difference between an aquarium and the ocean and the fact that oil concentrations in the water during a spill are rarely known. Rice (1973) has noted that in laboratory studies, pink salmon fry are able to detect low, sublethal concentrations (as low as 1.6

mg/l of oil for older fry) of Prudhoe Bay crude and show avoidance behavior to it. He acknowledges that the effects of sublethal concentrations of oil on salmon migrations are unknown, but emphasizes that the potential for harm is clear. Salmon, of course, do not inhabit the Gulf of Mexico, but there are many migratory fish species in the Gulf.

Blumer (1969) has proposed that physiological/behavioral effects may interfere with fish nutrition by:

a) blocking taste receptors, and

b) mimicking natural chemical messengers which attract predators to their prey.

Boesch (1973) cites the unpublished work of Todd and Atena (Woods Hole Oceanographic Institution, Chemotaxis Group). They worked with behavior patterns of yellow bullheads, Ictalurus natalis. They found that the fishes complex, chemically-mediated social behavior developed high intensity conflict behavior when exposed to water soluble fractions of Kuwait crude oil.

It is also significant that fish could suffer stress from feeding on contaminated prey such as the oil-ingesting copepods mentioned in IV.B.2.a.(1) above.

No information has been found on spilled oil affecting numbers of the nekton other than finfish. Brownell (1971) and LeBoef (1971)

investigated the effect on marine mammals of the Santa Barbara oil spill. Numerous dead animals found after the spill, including gray, sperm, and pilot whales, dolphins, and elephant seal pups, were examined histologically and chemically for the presence of oil or pathological effects related to oil. No such oil or pathology was found and the deaths were attributed to natural causes. It was also noted that the number of deaths was not abnormally high.

Numerous marine mammals are known to inhabit the Louisiana waters for part of their life histories: the bottle-nosed porpoise, and several whales including the blue, finback, humpback, sei, sperm, and pilot. The most common of these is the bottle-nosed porpoise, a frequent inhabitant of bays and seashore waters. The whales are not common, in fact they are on the Endangered Fauna listing of the U.S. Fish and Wildlife Service (section IV.H.6.). On the basis of the Santa Barbara spill data alone, it is difficult to predict effects of an oil spill on these animals, however, we presume it will be negligible so long as the mammals are able to escape the area of the spill.

In summary, we are unable to predict the total scope of the impact on nekton in quantitative terms. Based on past observations, we estimate that the overall impact will be minimal.

2. Impact on Benthic Marine Life

Environmental impacts which may be expected to affect benthic life adversely will result from the discharge of drill cuttings, accidental spillage of oil (and associated use of emulsifiers) and other toxic materials, and the burial of newly constructed pipelines.

Spilled oil which has not evaporated or been cleaned up or stranded on a beach, after being dispersed into the water as droplets, adheres to particulate matter and sinks to the bottom where it comes into direct contact with the benthos.

Data of Sanders, Grassle, and Hampson (1972) show immediate and nearly complete mortality of many forms of benthic animals following the spill of No. 2 fuel oil near West Falmouth, Massachusetts. The bivalve molluscs (clams, etc.) seemed especially vulnerable. As a rule, when levels of oil concentration in the sediment apparently decrease below a certain level with the passing of time, affected areas were recolonized by resistant forms, especially the marine polychaetous worm Capitella capitata. This generally occurred within three to six months of the initial oiling. With the passage of about 10 to 20 months, the more sensitive molluscs resettled many areas. However, at some harbor stations which apparently received a heavy oiling, some highly sensitive forms such as the

ampeliscid amphipods 1/ had not returned. Farther offshore, this required about six months.

During drilling operations, drill cuttings are separated from the drilling fluid, cleaned of any entrained oil, and discharged into the ocean. A diver survey during one operation offshore Louisiana revealed that the drill cuttings could be detected over a circle 100 feet in diameter. In a small area in the center, the deposit appeared to be about four feet thick. The same survey of the cuttings deposit showed that benthic animals either migrated up through the deposit as it accumulated or colonized even as deposition continued, because it appeared to be inhabited by several animals characteristic of "normal" benthic fauna. 2/

The number of wells that contributed to the pile of cuttings noted in this diver survey was not indicated. As noted in section III.A.3.b., a typical 10,000 foot well may generate 700 tons of cuttings, and up to 20-30 wells may be drilled from a single platform. It is our opinion that the 100 ft. diameter pile of cuttings may represent cuttings from one or a few wells. The total amount of cuttings from 20 to 30 wells would probably cover a larger area around the base of a platform. The distribution of these cuttings would depend on currents and on size of the cuttings.

1/ A family of crustaceans related to the common beach hopper or beach flea.

2/ Henry Hill, Continental Oil Company, Personal Communication.

If drilling operations were carried out over the relatively harder carbonate sand bottoms, it is possible that the highly productive seagrass beds might be smothered by the drill cuttings which are discharged overboard. Unfortunately, the offshore distribution of grasses is apparently patchy and not well known. Therefore, it cannot be said with certainty that such an impact would occur.

Also associated with these relatively hard bottoms are small to large populations of non-burrowing, attached benthic animals such as the sponges, soft corals, anemones, bryozoans, and others. The extent and duration of the impact are impossible to predict at this time. If the drill cuttings are similar in consistency and composition, colonization and repopulation could proceed rapidly. If, on the other hand, the drill cuttings were wholly foreign in consistency and composition, the deposit might remain barren for a long period or be populated by different types and numbers of animals.

The effect of drill cuttings may be further complicated by the periodic discharge of non-oil based drilling muds. In the past these have been assumed to be harmless. However, drilling muds often contain large amounts of barium compounds (sec. III.A.). The barium in drilling muds represents a serious, but as yet undetermined, threat to aquatic life, because it is known from

upland operations that barium compounds have a severe, almost sterilizing effect on plant and animal life of the soil. 1/

Investigating on behalf of the Gulf Universities Research Consortium Offshore Ecology Investigations (1974), Dr. James I. Jones has found barium compounds to be above "normal" background levels in sediments of Grand Isle, Louisiana, where drilling has gone on for many years. Nevertheless, they are low enough to present no known biological hazards. Considered separately from drilling muds, we do not expect the regular discharge of drill cuttings to result in a reduction of the benthic communities of the continental shelf.

In water depths of less than 200 feet new pipelines are entrenched by jetting away the sediment beneath the pipe and allowing the pipe to settle into the underlying trench. Subsequent burial is allowed to take place naturally, primarily by reworking of sediments by bottom currents. The jetting process physically disrupts the sediments in its path and also causes resuspension of large quantities of sediment.

Most, if not all, benthic fauna are either destroyed by the jetting or raised into the surrounding water and rendered completely vulnerable to predation. Although recolonization would begin immediately, the native fauna could not be fully restored until

---

1/ Environmental Protection Agency: "Economic and Social Importance of Estuaries". Estuarine Pollution Study Series No. 2. EPA Water Quality Office.

seasonal reproduction cycles had been completed by representative species from adjacent areas, which would provide a supply of larvae to settle and enter the reworked substrate.

Turbidity resulting from resuspended sediment is capable of producing an adverse impact on filter-feeding molluscan and crustacean benthos by clogging the filter-feeding apparatus or blocking respiratory surfaces. Casual observation has revealed that ocean currents carry the sediment and redeposit it at various distances, depending upon the particle size of the sediment.

Another possible source of impact during pipeline dredging is the resuspension of toxic heavy metals and persistent pesticides that may have been deposited in the area by a polluted stream and land runoff. The possibility exists that these toxic materials could be ingested by lower marine life and could then be magnified through the food chain until they accumulated in serious quantities in top carnivores, including species harvested for human food.

Obviously, we must conclude that the benthic community will be disrupted or destroyed in the path of pipeline dredging operations. We believe the duration of the impact will be short, with recolonization being completed within a year or two. The possibility of impact by resuspended toxic heavy metals and persistent pesticides exists, but the potential for the occurrence, location, scope and duration of the impact are unknown.

C. Impact on the Communities of the Coastal Zone

The wetlands include the Mississippi River mudflats, saline, brackish, intermediate, and freshwater marshes of the Louisiana chenier and deltas and the fringing saltmarshes on the landward side of the barrier islands. Estuarine areas encompass the marshes of Eastern Louisiana along the perimeter of the Gulf of Mexico and are found all along the Louisiana coast. These areas have been described in detail in Sec. II.D.1-5 and II.D.8. Dominant marsh vegetation consists of marsh grasses. Algae and epiphytes are also among the common primary producers. Dominant marsh fauna include the detrital consumers and insects, although the most noticeable animals are the waterfowl and other birds, the furbearing mammals and, in the less saline marshes, the American alligator. Marsh fauna is further described in Section II.D.6.

Adverse impacts resulting from offshore oil production which are possible in the wetlands and estuaries of Louisiana include: pollution by crude oil and subsequent hydrocarbon uptake by organisms, environmental disturbance of habitats during pipeline construction operations, and loss of habitat when land is utilized for onshore pipeline terminals, gas and oil treating facilities.

A representative of the industry considers that the existing pipeline system will be adequate to contain new production

resulting from this sale. However, should pipeline construction be later deemed necessary, an Environmental Analysis Record will be written by the Bureau of Land Management to study the environmental effects of the pipeline construction and burial, and of onshore facilities.

We add that although pipeline installation severely affects organisms in the areas of construction, past experience in the northeastern coastal Texas marsh - which is similar to parts of the western Chenier of Louisiana - has shown that recovery of biota over the refilled pipeline ditches is largely completed during the following growing season. During recent field reconnaissance by Bureau of Land Management personnel, which included aerial surveillance in addition to surface travel and onsite inspection, it proved difficult and in some cases impossible to locate the routes of several pipelines laid through the marsh of eastern Texas three years before. However, in the deltaic marshes of eastern Louisiana, the flotation of oil pipelines in canals up to 40 feet wide create a permanent alteration of the environment (St. Amant, 1971) as was also witnessed by Bureau of Land Management personnel. Changes in water circulation resulting from such canals may be impeded by the construction of dams and gates. However, pipeline flotation and access canals are believed by some to be responsible for an increasing erosion rate of the

marshlands (St. Amant, 1970, Gagliano and van Beck, 1970). In order to minimize ecological damage which results from such canal dredging, it has been suggested (St. Amant, 1972) that pipelines should be confined to specific corridors and should not be constructed at random from point to point and dredging done in such a way as not to disrupt normal drainage patterns.

Depending upon the quantity and frequency of crude oil being dispersed into the ecosystem and the time of exposure of organisms to these hydrocarbons, the introduction of petroleum into the ecosystem may create disturbances hazardous to the environment. Existing information on the actual effects of hydrocarbons on estuarine and wetland life is far from conclusive. However, accounts of biologic disruptions, or the lack thereof, following accidental spills from tankers and their operations (an activity unrelated to offshore production), from several controlled experiments, and faunal surveys in areas of oil production, do provide some basis for understanding the role of crude petroleum in the ecosystem. Future studies in waters considered for possible leasing will considerably broaden the basis. Whenever possible, the following sections discuss possible impacts on biota with respect to such factors as quantity, frequency of occurrence, and duration of hydrocarbons in the marshes, bay and sound, beaches, and artificial and hard substrates of Louisiana. Pertinent information will be included,

when available, concerning such categories of potential impacts as organisms response to oil, direct toxicities, both lethal and sub-lethal, incorporation or uptake of hydrocarbons by organisms, and oil coating.

1. Bays and Estuaries

Largely depending on the quantity and composition of oil spills, differing impacts may be expected which are directly related to oil concentrations near the spill area. Large spills such as those resulting from tanker accidents, have demonstrated that definite biological damage can result from exposure of living organisms to high concentrations of petroleum hydrocarbons. For example, when the Tampico-Maru ran aground off the coast of Baja, California in 1957, 50,000 to 60,000 barrels of diesel fuel caused widespread mortality among many benthic organisms of the area. These animals included lobsters, abalones, sea urchins, starfish, mussels, clams and smaller forms. Such damage occurred along the shoreline and up to depths of 15 to 25 feet (North, 1973, Ketchum, 1973). Recovery occurred gradually over several years' time and began with a profuse bloom of subtidal algae within four months after the wreck (North, 1973). This latter development probably resulted from the absence of grazing animals which had been eliminated by the spill. The diesel fuel of the Tampico-Maru would be considered more highly toxic than the crude oil produced by offshore drilling operations because it contained

marshlands (St. Amant, 1970, Gagliano and van Beck, 1970). In order to minimize ecological damage which results from such canal dredging, it has been suggested (St. Amant, 1972) that pipelines should be confined to specific corridors and should not be constructed at random from point to point and dredging done in such a way as not to disrupt normal drainage patterns.

Depending upon the quantity and frequency of crude oil being dispersed into the ecosystem and the time of exposure of organisms to these hydrocarbons, the introduction of petroleum into the ecosystem may create disturbances hazardous to the environment. Existing information on the actual effects of hydrocarbons on estuarine and wetland life is far from conclusive. However, accounts of biologic disruptions, or the lack thereof, following accidental spills from tankers and their operations (an activity unrelated to offshore production), from several controlled experiments, and faunal surveys in areas of oil production, do provide some basis for understanding the role of crude petroleum in the ecosystem. Future studies in waters considered for possible leasing will considerably broaden the basis. Whenever possible, the following sections discuss possible impacts on biota with respect to such factors as quantity, frequency of occurrence, and duration of hydrocarbons in the marshes, bay and sound, beaches, and artificial and hard substrates of Louisiana. Pertinent information will be included,

when available, concerning such categories of potential impacts as organisms response to oil, direct toxicities, both lethal and sub-lethal, incorporation or uptake of hydrocarbons by organisms, and oil coating.

1. Bays and Estuaries

Largely depending on the quantity and composition of oil spills, differing impacts may be expected which are directly related to oil concentrations near the spill area. Large spills such as those resulting from tanker accidents, have demonstrated that definite biological damage can result from exposure of living organisms to high concentrations of petroleum hydrocarbons. For example, when the *Tampico-Maru* ran aground off the coast of Baja, California in 1957, 50,000 to 60,000 barrels of diesel fuel caused widespread mortality among many benthic organisms of the area. These animals included lobsters, abalones, sea urchins, starfish, mussels, clams and smaller forms. Such damage occurred along the shoreline and up to depths of 15 to 25 feet (North, 1973, Ketchum, 1973). Recovery occurred gradually over several years' time and began with a profuse bloom of subtidal algae within four months after the wreck (North, 1973). This latter development probably resulted from the absence of grazing animals which had been eliminated by the spill. The diesel fuel of the *Tampico-Maru* would be considered more highly toxic than the crude oil produced by offshore drilling operations because it contained

a greater concentration of aromatic hydrocarbons. Petroleum which contains a greater amount of aromatics are usually considered more toxic (R. C. Clark, 1973). However, both crude oils and their refined products contain compounds that are toxic to species of marine organisms (Ketçhum, 1973).

Studies on toxicities of petroleum on marine organisms are increasing in number. Mironov (1971) as cited by Ketchum (1973) tested toxicities of crude oil (unspecified type) on eleven phytoplankton species and found that cell division was delayed or inhibited by oil concentrations ranging from .01 to 1000 ppm and that copepods were sensitive to a 1 ppm suspension of fresh or weathered crude oil. In addition to inhibiting the growth of suspended phytoplankton in the water column, similar effects may be expected upon cells of benthic and epiphytic algae along the bottom and edges of estuaries (Stone, 1972)

According to Boesch (1973), several early studies have demonstrated the effect of petroleum hydrocarbons in retarding phytoplanktonic growth although he states that "...little is known of how oil affects physiological processes of organisms other than vascular plants". According to Boesch:

> "Gordon and Prouse (1972) studied <u>in situ</u> the effects of some crude and refined oils on marine phytoplankton phytosynthesis. At low concentrations (less than 45

ug/l bicarbonate uptake 1/ was increased as much as 20% over controls. At concentrations greater than 50 to 100 ug/l of crude and No. 2 and No. 6 fuel oils, uptake was significantly decreased."

Yet North (1973) states that our knowledge of the effects of petroleum upon phytoplankton is "woefully inadequate". He affirms that while large scale effects on permanently planktonic species may be small, influences on larvae and reproductive cells of benthic species might be significant.

The bays and estuaries of Louisiana are a highly productive ecosystem as is emphasized in Section II.D.8. Detrimental effects upon the primary productivity of these ecosystems would result in a decrease in the planktonic food supply of the large menhaden, shrimp and other fisheries in addition to directly toxic effects of crude petroleum on the fauna and flora. Ketchum (1973) cautions that while effects of petroleum depend upon proximity to and type of oil released, "Any release of oil into the environment carries a threat of destruction and constitutes a danger to world fisheries."

However, other authors believe the adverse effects of petroleum hydrocarbons on the biotic communities of Louisiana are less significant.

1/ Bicarbonate uptake is a measure of phytosynthetic activity.

St. Amant (1973), speaking of the oil producing structures in the bays, offshore areas and marshes of his State says:

> "Louisiana's coastal areas with more than 25,000 producing wells, with some fields that have been in production for more than 40 years, and most of which has existed for 20 years, serves as a types area of high production and long-term pollution."

Yet St. Amant, aware of possible environmental damage which may result from "... chronic mismanagement of the environment...". (See section IV C 2) states:

> "Long-term exposure in Louisiana does not seem to have resulted in significant changes in the biotic productivity of the marine system and the presence of normally occurring hydrocarbons at levels of from 100 to 500 ppm. in bottom mud tend to confuse attempts to determine accumulative levels of petroleum hydrocarbon in the substrate."

While studies cited previously in this section indicate the retarding effect of petroleum or primary productivity, it is St. Amant's opinion based on his experience that there has been no decrease in overall productivity in Louisiana resulting from introduction of crude oils into the ecosystem (St. Amant, 1973).

The presence of oil consuming microbes which consume limited amounts of hydrocarbons as documented for Barataria Bay, Louisiana (Stone, 1972) may partially account for the reported lack of environmental damage.

Onuf (1973) studied the effects of petroleum in the field near refinery effluents, natural seeps and drilling operations and in the laboratory. He cites a study of Spears (1971) in which the biological effects of oil production upon estuarine organisms were considered. In the study, Spears compared the yield of harvestable organisms from waters receiving oil field wastes in Texas with nearby waters which were relatively unaffected by human activity and concluded that there was a serious detrimental effect to commercially important organisms due to oil field wastes. However, the high concentration of oil in the creek under study (16 ppm) and the effects of brine effluents made it hard to extend the study to other situations. Onuf finally concludes that "...demonstrable effects of long term pollution by oil are very local and often associated with concentrations that approach acutely toxic levels. Where more general effects have been suggested, confounding factors have not been satisfactorily discriminated." According to Onuf:

> "The fact that a long period of large scale oil extracting activities has not reduced the productivity of major fisheries along the Gulf Coast of Louisiana suggests that many populations in offshore regions can accommodate long term, low level intrusions of oil. The case for estuaries cannot be so succinctly stated nor dismissed. No respectable field experiments (on estuaries) have been reported."

Onuf points out that lab experiments have revealed "...dislocations of normal behavior..." by organisms in concentrations of oil found in some polluted estuaries and that adverse synergistic interactions between low concentrations of oil and temperature/salinity stresses

are of such dangerous magnitude that they warrant direct testing by field experiments. He feels that refinery effluents cause more environmental harm than drilling operations, although he maintains that no predictions are possible on how serious the damage may be.

Individual faunas have been studied for their biological responses to oil. The effects of oil on subtidal benthic communities such as those found in bays were studied by Fauchald (1971) in response to the Santa Barbara spill. One of the major organisms studied was the frequently occurring marine worm Listriolobus pelodes (not present in the northern Gulf of Mexico). Fauchald concluded:

> "There are no indications that it has been totally exterminated, or even reduced markedly in the vicinity of Platform A. In fact, in one of the box cores taken in October, 1969, as part of a bacteriological survey, a relatively small but otherwise normal, L. pelodes was found sitting in its shallow depression surrounded by an inch-thick layer of block mud mixed with crude oil."

The author theorized that fluctuations in numbers of benthic animals observed may have been due to natural causes or oil well drilling in the area, from the oil spill or from sewage pollution. Unfortunately, he could not isolate the effects resulting from the spill alone.

In the Arrow spill study (Operation Oil, 1970), lobsters appeared to be clean and normal in behavior. Scallops taken near heavily oiled beaches had no oily taste, but chemical analysis of scallops, along with periwinkles, sea urchins, and other bottom

dwelling organisms revealed that oil was present in muscle tissue, the digestive tract and other organs.

Galtsoff (1959) noted that the major effects of industrial wastes and the soluble components of crude oil on oysters is a reduction in the rate of various physiological functions, principally ventilation of the gills. Specifically, these pollutants cause a reduction in the amount of time during which an oyster opens its valves for feeding and respiration, and also interferes with the coordination of the ciliary motion with the result that the pumping capacity of the gills is reduced. The reduction in feeding time (simultaneous with respiration) results in a lowered growth rate and poorer quality oyster meats. It is well known that oysters can become contaminated with oil (Erhardt, 1972; Galtsoff, op. cit.; Mackin, 1962) but there is still scientific debate as to whether oysters can cleanse themselves when returned to clean water. See also Section IV.C.3. on shellfishes.

Teal and Stegeman (1973) exposed to oil two oyster populations differing in fat (lipid) content and found that petroleum hydrocarbons were accumulated by both groups of oysters. The oysters with a higher lipid content collected the greater wet weight of hydrocarbons, although the two populations were similar on a lipid weight basis. When these animals were returned to clean water, the hydrocarbon content was rapidly, though incompletely, discharged. These researchers also found that the petroleum contained in the oysters differed from the contaminating oil by showing a greater

percentage of aromatics. This result suggested that a higher percentage of aromatic fractions of oil were more likely to be incorporated into the oyster's tissue. The possibility that the oysters were themselves modifying the oil could not be discounted, however.

The accumulation of hydrocarbons in oyster tissue, as was demonstrated by Teal and Stegeman (1973), raises the question of petroleum hydrocarbon incorporation into other members of a food chain which eventually reach higher animals. There is, at present, no evidence that petroleum hydrocarbons are magnified in higher levels of the food chain through consumption of contaminated oysters or fish.

According to Boesch (1973):

> "It has been suggested that petroleum hydrocarbons might be taken up by organisms, protected from degradation, accumulated and concentrated along a food chain."

Blumer, Mullin and Guillard (1970) found that a biogenic or natural hydrocarbon produced by certain marine phytoplankters may be accumulated by the copepod, Rhincalanus nasutus and the hydrocarbon was also found in oysters, herring and shark's liver. Yet, the larvae of the barnacle Balanus ballanoides maintained in a suspension of crude oil, ingest, without apparent harm, droplets of oil which later appear in the feces (Freegarde, et al, 1970) as cited in Ketchum (1973)). On the other hand, according to Ketchum (1973):

"Hydrocarbons ingested by marine organisms may pass through the wall of the gut and become part of the lipid pool 1/ (Blumer, et al., 1970). When dissolved within the fatty tissue of the organisms, even relatively unstable hydrocarbons are preserved. They are protected from bacterial attack and can be transferred from food organisms to predators and possibly to humans."

Boesch's (1973) conclusion is, that "...although it appears that petroleum hydrocarbons can be transferred via feeding, at this time there is no convincing evidence for biological magnification as documented for chlorinated hydrocarbons."

In summary, while current research indicates the potential hazards of chronic hydrocarbon addition to the environment, field observations in Louisiana do not indicate that chronic pollution has reduced overall productivity. However, in the matrix analysis, those tracts which rate units of 50 or more in categories which consider effects on estuarine life (highly productive areas) and fishing should be singled out for particular consideration on environmental impact.

1/ Lipid pool - collection in tissue of a group of organic compounds which make up the fats.

2. Marshes

The delicately balanced marshland ecosystems which have been described in Section II D. 1-5 of this statement are subject to impacts resulting from sporadic accidental spillages and from chronic oil pollutants and pipeline construction. In the absence of tanker operations, accidental oil discharges will be restricted to oil washed ashore from unforeseen platform accidents or pipeline rupture. Chronic pollutants may result from pipeline leaking and refinery effluents. St. Amant views chronic pollution as posing greater environmental jeopardy than the more obvious damage which results from accidental oil spills. To quote St. Amant (1972) directly:

> "Significant ecological or environmental damage must be viewed as a permanent or long term change in the ecosystem that reduces its efficiency and subtracts from its overall productivity. Such a change may be the result of sudden catastrophic events with obvious results; more often, it represents the long term cumulative effects of apparently innocuous happenings and of chronic mismanagement of the environment."

While little has been done to methodically answer ecological questions concerning effect of hydrocarbons on highly productive marshland ecosystems, some recent advances have been made. It has been established that large inputs of petroleum into marshlands may result in immediate faunal mortalities and the retarding of floral species.

For example, British studies of salt marsh oiling followed a "moderately severe" spill of crude oil from the tanker Chryssi P. Goulandeis in Milford Haven estuary, Wales (Baker, 1971; Cowell, 1969; Cowell and Baker, 1969). A survey two weeks after the spill showed that oily saltmarsh vegetation had yellowed and was dying although new green growth was showing at the base of some species. Some plant communities remained without new growth a year later. While observations were not made on saltmarsh fauna, mortality was presumed high for aquatic animals in the spill area.

Baker (1971) sprayed saltmarshes in southwest Wales with fresh Kuwait crude oil at different times of the year. Results indicated that a light pollution with crude caused little long term damage to most salt marsh plants, whatever time of the year the pollution occurred, although most damage occurred in warm months. Oiled leaves died but perennial plants recovered well with new growth; annual plants were severely reduced in numbers because they could not recover by new growth before fall. Seed production of annuals was inhibited for one season.

Mackin, (as cited in Stone, 1972) studied the effects of crude oil on a number of Louisiana marsh grasses. The species included saltgrass, Distichilus spicata, cordgrass, Spartina alterniflora, and Bates grass Batis sp. which are the dominant species in the fresh and brackish marshes (Section II, D 1-2). Mackin's data strongly implied that long term exposure to petroleum at relatively high concentrations is

quite lethal, and that immediate and rapid cleanup is therefore critical and essential (Stone, 1972).

Boesch (1973) notes that while:

> "... more study and quantification are required, it seems likely that petroleum hydrocarbons, even those not soluble enough to be directly lethal, may inhibit photosynthesis for a short time and under the proper conditions."

The proper conditions refer, in part, to exposure of plant organisms to petroleum hydrocarbons at concentrations greater than 50 to 100 ug/l (Gordon and Proust, 1972) as cited by Boesch (1973) and quoted in Section IV.e.1.

Because of the obvious harm incurred upon marshes from exposure to large spills and the importance of these wetlands as an energy producing area, tracts which rate a value of over 50 in the matrix analysis for "highly productive areas" and refuges/management areas should be singled out for particular environmental consideration.

3. Beaches

The beaches in Louisiana include the sandy beaches which border the Gulf of Mexico side of the barrier islands and the beach along the Chenier ridge of along the westernmost shoreline of the mainland. OCS oil producing areas are found primarily in the eastern half of offshore Louisiana.

Beach fauna suffer a severe impact from offshore oil spills as is evidenced by the results from several previous accidents. Crude oil from the Santa Barbara and Torrey Canyon spills reached the beaches causing mortalities of intertidal and beach fauna. Much of the mortalities in the Santa Barbara incident were due to smothering of intertidal animals by coating with crude oil. Mitchell (et al, 1970), noted that populations of mussels, barnacle, and periwinkles survived the initial exposure in the absence of "tar" coating. According to Ketchum (1973):

> "At locations where the oil film (of Santa Barbara) was not so obvious intertidal organisms were not severely damaged (originally Foster et al, 1970)."

Detergents used to disperse oil in the Torrey Canyon spill complicate an assessment of damage caused by the oil. However, indications were that mortalities were light on beaches where detergents were not employed (North, 1973).

The spill of #2 fuel oil in West Falmouth, Massachusetts, from the tanker Florida resulted in a high number of mortalities among intertidal and beach fauna. This spill eventually covered nearly three miles of coastline and resulted in high mortalities (Blumer et al, 1971). Results from studies of this spill demonstrate that immediate catastrophic and later chronic effects can result from a single oil spill

(Sanders, 1973). In this paper Sanders concluded that species density patterns for polychaetes, gastropods, bivalves, and ampeliscid amphipods which are residents of the subtidal benthos, follow stress patterns depending on distance from the spill and time of exposure of organisms to the fuel oil.

Most pollution studies for the littoral zone are concerned with rocky shoreline of New England and California and their characteristic assemblages of seaweeds, barnacles, limpets, anenomes, etc., ... rather than for the less extensively studied sandy beach communities. To generalize, where organisms have been covered by crude oil and Bunker C fuel oil, death is primarily blamed on smothering due to physical coating (e.g. Chan, 1972; Nicholson and Cimberg, 1971). When the pollutant has been a lighter refined fuel oil, mortalities and stress have been primarily associated with toxic effects of the oil (e.g. North, Neushul and Clendenning, 1964).

In the event of a major spill beach communities may be expected to suffer considerable damage. Effects on birdlife are discussed in a separate section. Tracts which rate a factor above 50 for the category of beaches should be singled out for particular environmental consideration.

4. Artificial and hard substrate communities

Communities of animals on artificial and hard substrates are most common along the jetties and pilings which protect the entrances to

Mississippi River passes and along the numerous pilings and boat docking structures distributed along the coast. They are also found on oil drilling and producing structures.

Although communities of anenomes, limpets, mollusks, barnacles and other forms of marine/estuarine life which attach themselves to the substrate are prolific in California and New England, few of these animals have a wide distribution in Louisiana because of the predominately soft-substrate beaches of the State. Those invertebrate sessile 1/ organisms which do colonize the jetties of the Mississippi River are largely protected from contact with oil resulting from a spill due to the Gulfward movements of the River.

Studing the effects of the Chedabucto Bay spill of Bunker C oil, Thomas (1973) found that most of the 20 species of animals observed suffered from the effects of coating with subsequent smothering of animals but were otherwise little affected. Barnacles showed no unusual mortalities and settlement of larvae occurred in following seasons. Periwinkles, common intertidal mollusks, remained abundant and continued to occupy the same general zones. A seaweed, Fucus, however, declined over the next 10 months and, where oiling was severe, recolonization had not been successful at the time of publication (1973).

Attached seaweed which declined as a result of contact with petroleum hydrocarbons dispersed from the Torrey Canyon, later recovered in the absence of grazing organisms (Stebbings, 1970) cited in Thomas, 1973.

1/ sessile = non-moving; attached

The effect of hydrocarbons upon artificial and hard substrate communities will be considered under the heading of beaches in the matrix analysis. Particular environmental consideration should be given to these tracts.

5. Impact on Birdlife

In the past, the injuries and deaths of thousands of seabirds, shorebirds and waterfowl have been the most obvious impacts of massive oil spills. According to R. B. Clark (1973), the only organisms damaged directly by oil pollution on a sufficient scale to affect the world, or even local populations, are seabirds. While seabirds such as auks (murres, Uria omvia, razorbills, Alca torda, puffins, Fratercula arctica, and guille mots, Cepphus grylle), may be considered as part of the offshore environment for a considerable part of their lives, shorebirds and waterfowl spend a greater percentage of their life in the coastal zone.

Although the auks, and puffins (Order Pygopodes - diving birds, family Alcidae), which are the subject of R. B. Clark's (1973) study, are arctic and do not inhabit the Louisiana coastal or offshore environment, several closely related seabirds do inhabit these environment during the winter months. These related birds, which belong to the same Order as the auks are the grebes (family Colymbidae) and loons (family Gaviidae). Estuarine birds are listed in Section II.D.6.

The causes of mortality and damage to bird fauna from hydrocarbon contamination are usually complex and may result from several interacting factors. Shelton (1971) states that:

> "Clogging of plummage greatly reduces (a bird's) insulating properties, while injestion of oil during preening can cause a variety of pathological conditions including severe enteritis and necrosis of the duodenum... This, in combination with increased heat losses, may reduce feeding activity and a marked drop then occurs in the fat reserves of the bird. It is in this critical condition that most oiled birds arrive on the shore where further stresses are put on them by cleaning and attempts at rehabilitation. It is therefore not surprising that the mortality rate of cleaning centers is very high indeed."

Table 11 on the following page lists the recent oil spill related mortalities as noted in the literature.

Internal contamination of birdlife may follow preening of feathers. Internal toxicity by polluting oils is a definite factor in the observed mortalities due to exposure to petroleum hydrocarbons as was demonstrated by Hartung and Hunt (1966) as cited in Ketchum (1973). These experiments determined the lethal dose of oil to certain ducks ranges from 1 to 4 ml per kilogram (ml/kg) when the birds were kept outdoors under environmental stress. A duck was expected to clean 50% of the polluting oil from its feathers during the first few days after contamination. Hartung and Hunt concluded that if a duck acquired 7 grams of oil on its feathers, it could ingest oil to meet the experimentally established lethal dose of 1 to 4 ml/kg.

The effects of long term chronic pollution on birds in Great Britain have been studied by R.B. Clark (1973). Auks, arctic species

Tablell. Some Oil Spill-Related Bird Mortalities, World-wide

No. Birds Affected	Source of Spill	Material Spilled	Quantities	Location	Year
3,600	Platform	crude oil	18,500 bbl.	Santa Barbara, Calif.	1969 a,f
200	not specified	light diesel oil		Firth of Forth, Scotland	1969 b
9,000 (60% auks)	not specified	heavy fuel oil		Aberdeenshire, Scotland	1970 b
1,000	not specified	"Oil"		Southwest England	1970 b
12,000 (Contaminated) (mostly guillemots)		fuel oil		Northeast England	1970 b
1,000 (Contaminated)	Tanker			Southern England	1970 b
2,300 (ducks, grebes, auks)	Tanker <u>Arrow</u>	Bunker C	36,000 bbl.	Chedabuctor Bay, Nova Scotia	1970 b
None	Platform-Chevron	crude oil	30,500 bbl.	Offshore Louisiana	1970 b,f
3,500 (Contaminated	Tanker <u>Delian Appollon</u>	Bunker C	240 bbl.	Tampa Bay, Florida	1970 c
1,000 (Contamined)	not specified	weathered oil		Martha's Vinyard, Mass.	1970 b
96,000	not specified	"Oil"		Kodiak and adjacent Is., Alas.	1970 b
none	Shell Platform	crude oil		Offshore Louisiana	1970 d
6,000	Tanker Oregon Standard	Bunker C	45,000 bbl.	San Francisco Bay, Calif.	1971 e
none	Amoco Platform	crude oil	several small slicks	Offshore Louisiana	1971 d,g

a--Straughan, 1971a. b--<u>Environment</u> Editorial Staff, 1971. c--Unpub. Rep., Florida Game and Freshwater Fish Comm., Tallahassee.

d --Testiomny of Dr. Carl Oppenheimer, OCS Public Hearing, New Orleans, Louisiana. Aug. 23, 1972.

e--Chan, 1972. f--U.S. Geological Survey, 1972. g--Baker, J., 1971. A review of world oil spillages, 1960-71. Oil pollution research unit. Pembroke, Pembrokshire, England.

which migrate to Great Britain (and again are similar to grebes and loons) have a low rate of replacement and are thus more susceptible in the long-term to high early mortality from natural causes than those which are more prolific. Clark states that "Diving sea ducks have a greater reproductive potential and do not appear to have declined despite repeated heavy losses from oil pollution" (an exception is made for long tailed ducks and for velvet scoters).

An illustration of the operating dynamics in bird populations is described by R. B. Clark (1973) referring to the eiders, Somateria sp. Eiders, northern ducks which do not inhabit Louisiana, are related to the ring-necked duck, Aythya collaris, lesser scaup duck, Aythya affinis, redhead, Aythya americana, pintail, Conas acuta, shoveler, Spatula clypeata, gadwell, Anas strepera, green winged teal, Anas carolinensis, canvas-back, Aythya valisineria, and other members of the family Anatidae (ducks).

> "It is possible to kill a larger proportion of a local (eider) population by a single oil spill in winter: 50% of the Jay estuary population was lost in 1968 in the Tank Duchess oil spill (Greenwood and Kiddie, 1969). Furthermore, since the birds return to the same nests to breed in successive years, losses must be made good by their survivors. After the Palva oil spill in the Kokar peninsula, in which 25-33% of the local population was killed, reproduction in the following year was exceptionally successful and recovery of the population is expected to be rapid (Soikkeli and Virtanen, 1972)."

Several European populations of seabirds have declined significantly and this is attributed to both major and minor spills from shipping accidents, tanker discharges, oily wastes from shore discharges (R.B Clark, 1973). However, downward trends in European bird populations may also be the unfortunate result of industrial pollution other than from petroleum. The use of pipeline transport systems in Louisiana will prevent spillage from the above sources, although potential pipeline leakage must be considered as a possible source of oil.

In the Gulf of Mexico, bird mortalities due to oil pollution are less frequent due to the fewer number of spills which have occurred there. However, damage to birdlife has been documented for the oil spill in Tampa Bay, Florida. On February 14, 1970, the Tanker Delian Appolon ran aground, spilling a cargo of Bunker C oil into Tampa Bay. It was not possible to assess with accuracy the total number of birds harmed or killed because of the northward migration of waterfowl then occurring. Presumably, some of the oiled birds left the immediate area during their migratory flight. It is known that approximately 3,500 oiled birds were captured and treated although an accurate measure of success is not

given (Florida Game and Freshwater Fish Commission, unpublished Report). R. B. Clark (1973) estimates that, as a rule, only 10-25% oiled birds which die offshore wash up onto the beach. He does not estimate the number which make it to shore after contamination.

During March, 1970, an oil spill occurred at the Chevron platform "C" located 10 miles east of the 48,000 acre Delta National Wildlife Refuge and 9 miles southeast of the 7,500 acre Breton National Wildlife Refuge situated on Breton and Chandeleur Islands. The Department of the Interior (1970) reported little unfavorable impact to birdlife as a result of this spill because it occurred at a time when many species were temporarily in their northern breeding grounds. In addition, the Mississippi River riptide served as an effective barrier to the shoreward movement of oil when onshore winds did occur. According to the report, however, had the spill occurred earlier in the year or during the winter, large numbers of migratory waterfowl could have been destroyed.

Indirect impacts from OCS operations which would result from pipeline burial through beach and marsh areas would result in the loss of all nesting areas in the path of the pipeline.

In the matrix analysis, those tracts which rate an environmental impact factor of 50 for beaches, refuge/management areas, should be given particular consideration for the effects of oil contamination of shorebirds.

TREATMENT OF OILED BIRDS

The following summarizes some of the observations by R. B. Clark (1973) and others on the subject of treating oiled birds which have been the victims of a spill.

Treating of oiled birds has a history of lack of success due to additional stress put upon the animal by handling, toxic effects of detergents, the need for a long recovery time in captivity, loss of water repelling activities and increased susceptibility to disease.

Some cleaning methods have recently been developed which will assist the general public in caring for oiled birds with a greater degree of success than has previously been the case and are suggested for general use by R. B. Clark (1973).

In addition to the obvious necessity to promote safety to minimize spills of oil, this same author suggests that measures to reduce mortality during the migration and breeding season, would be the most direct way to counter losses caused by oil pollution.

D. Impact on Commercial Fisheries

Offshore oil and gas operations interfere with commercial Gulf fisheries in four general ways.

1. Removal of Sea Floor From Use

All shrimp and industrial bottom fish are caught by dragging a large trawl across the sea floor. All sites occupied by drilling or production platforms and attendant service boats and barges must be avoided by trawlers. If the structures are jack-up drilling rigs or permanent production platforms, the area of the sea floor removed would amount to 2 to 5 acres for each structure. In deeper waters (over 300 feet), a semi-submersible drilling rig with its anchoring system would occupy up to 325 acres (assuming a 1500 foot anchoring radius). The duration of exploratory drilling ranges from under 45 days for a single well to around six months for multiple well explorations. Permanent production platforms may remain in place for 10 to over 20 years.

Emplacement of structures on snapper and grouper banks may have an adverse effect on commercial fishing. Structures are known to attract large numbers of fish, including snappers and groupers, and if a structure attracted a significant portion of the resident populations of a bank, it may be more difficult to fish for these valued species, especially for the larger vessels which must maintain a safety clearance from the structure. This effect is speculative and has not been documented. What is known is that commercial and

sport fishermen do work around the rigs because of the sizable populations of snappers and groupers commonly found there.

Table 12 contains the tracts which the National Marine Fisheries Service has indicated as having rises or parts of rises which normally serve as snapper and grouper banks. "Depth of Rise" in Table 12 refers to the shallowest point of the rise, and "Bottom Depth" is the range of depth around the rises. We have further upgraded the proximity values of structures in the matrix analyses of these tracts to reflect the possible adverse effect on commercial fisheries.

The probability that permanent platforms will be erected on any given tract, based on past exploration success rates, is about 35%. In other words, approximately 1 out of every 3 tracts offered for lease will eventually require the erection of a platform (or platforms) for its development. Many tracts, about 2 of every 3 offered, may never be developed. It is estimated that each full tract (5,760 or 5,000 acres) developed will average two structures erected. Using the actual dimensions of a platform, two per tract would physically cover approximately 0.02% (1.8 to 1.0 acres) of each tract's sea floor. Taking into account a navigational safety zone around each structure and using the 2 to 5 acres per platform figure, trawlers may be denied up to 0.2% (10 acres) of the sea floor per developed tract.

Table 12 Tracts With Significant Rises or Parts of Rises Which Normally Serve As Snapper and/or Grouper Banks

Tract	Block	Depth of Rise (fm)	Bottom Depth (fm)
West Cameron Area			
16	114	3¼ - 4½	5¼ - 6¼
19	147	3½	6 - 6 3/4
Ship Shoal Area - South Addition			
165	350	29 - 45 (Possible Coral Reef)	59
South Timbalier Area - South Addition			
176	317	41 -	70 - 80
Garden Banks NG-15-2 Area			
214	N636E98	69 - 61 (Shoal)	111 - 136
217	N637E103	Part of 30½ - 36	100 - 110
226	N638E103	30½ - 36	110 - 112
227 SE/4	N638E106	35 lump within 57 Fm shoal	104 - 108
228	N638E107	Continuation of 57 shoal	121 - 175
235	N638E118	66	100 - 180
241 S	N639E103	36	110 - 117
242 S	N639E106	37 Shoal to 57	108 - 129
New Orleans - South No. 1 NG-15-3 Area			
250	N638E128	44 within 52-56	107 - 152

Total number of platforms required to develop a lease area and their spacing relative to each other are important factors in considering potential impact on commercial fishing activities. Because it is impossible to determine these factors in advance of a proposed sale, a special stipulation (see section V., Mitigating Measures) has been suggested as a responsive measure to an additional impact it is believed will result if careful planning and coordination are not undertaken.

2. Creation of Obstructions on the Sea Floor That Cause Damage to Trawling Nets

The obstructions referred to here are underwater stubs, large pieces of debris, and unburied pipelines.

The source and nature of stubs was described in section III. As already stated, Coast Guard regulations require that stubs be marked by a buoy at the surface if located in 200 feet or less or water and that the buoy be lighted if in 85 feet of water or less. If, between 85 feet and 200 feet, the stub is covered with a "bonnet" which would prevent snagging of fishing nets, etc., it may not be required to be buoyed. However, the Coast Guard has informed us that in spite of regular maintenance and replacement, these buoys are frequently found to be missing. If a trawler tows his net across a stub, the net will certainly be badly damaged or lost.

Large pieces of debris, such as equipment, piping, structural members, tools, and the like, may accidentally be lost off a platform, service boat or barge. If this occurs off or very near a platform, it may be located easily by divers and retrieved. However, if it is lost off a boat or barge underway, the location may not be known accurately

enough to allow its subsequent recovery. Depending on the size and weight of items lost in this way, varying amounts of damage may be done to trawling nets of fishermen unlucky enough to snag them.

It has also been reported 1/ that unburied pipelines (beyond the 200 foot depth contour) pose a serious problem to the shrimp trawling operations. The following table of shrimp catch statistics from the area between the Mobile Bay, Alabama to Sabine Lake, Louisiana emphasizes the catch by depth of water and value. 2/ These data were generated from NMFS Shrimp Fishing Grid Zones 11.0 through 17.2 and the internal water areas within the zones. (See Table 13).

Over 72 million pounds or 90.7% of the catch was harvested from waters landward of the 20 fathom depth contour. The monetary value of these heads-off dock side shrimp is more than $54 million or 84% of the total catch. The value per pound varies from $0.55 to $1.21 within the 20 fathom zone. Seaward of the 20 fathom contour the value by depth zone varies from $1.30 to $1.45 with the 31-35 fathom grouping being the highest. These data correspond to the generalized portrayal of shrimp grounds in Fig. 18. 3/

1/ Testimony of James C. Farrelly, President, Louisiana Shrimp Association, presented at August 23, 1972 OCS Public Hearing, New Orleans, Louisiana.

2/ Data from Department of Commerce, 1973, Gulf Coast Shrimp Data, Annual Summary, 1971, Current Fisheries Statistics No. 5925, National Marine Fisheries Service, NOAA.

3/ Fig. 1 is a composite portrayal of the shrimp fishery depicted in Bureau of Commercial Fisheries' Gulf of Mexico Shrimp Atlas, Circular 312, U.S. Department of the Interior, 1969.

Table 13 1971 Shrimp Catch by Depth of Water from Mobile Bay, Alabama to Sabine Lake, Louisiana. (units of thousands)

Species	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	+40		Total	Percent Species Caught
Brown	24,356	5,740	5,867	3,451	2,305	2,550	1,638	573	68		46,549	58.3
White	21,524	9,133	1,613	309	130	53	16	1	-		32,779	41.1
Pink	17	134	34	3	1	3	-	-	-		192	.2
Other	303	7	-	-	-	-	-	-	13		324	.4
Total	46,200	15,015	7,514	3,763	2,436	2,605	1,654	575	82		79,843	
Percent of Catch	57.8	18.8	9.4	4.7	3.1	3.3	2.1	0.7	0.1			
Value	25,376	16,449	8,014	4,568	3,366	3,709	2,398	822	106		64,808	
Percent of Value	39.2	25.3	12.4	7.0	5.2	5.7	3.7	1.3	.2			
Value per pound	0.55	1.10	1.07	1.21	1.38	1.42	1.45	1.43	1.30		0.81	

Reference: Department of Commerce 1973, Gulf Coast Shrimp Data, Annual Summary 1971, Current Fisheries Statistics No. 5925, NOAA XCFSA 5925 GCS, 30 p.

enough to allow its subsequent recovery. Depending on the size and weight of items lost in this way, varying amounts of damage may be done to trawling nets of fishermen unlucky enough to snag them.

It has also been reported 1/ that unburied pipelines (beyond the 200 foot depth contour) pose a serious problem to the shrimp trawling operations. The following table of shrimp catch statistics from the area between the Mobile Bay, Alabama to Sabine Lake, Louisiana emphasizes the catch by depth of water and value. 2/ These data were generated from NMFS Shrimp Fishing Grid Zones 11.0 through 17.2 and the internal water areas within the zones. (See Table 13).

Over 72 million pounds or 90.7% of the catch was harvested from waters landward of the 20 fathom depth contour. The monetary value of these heads-off dock side shrimp is more than $54 million or 84% of the total catch. The value per pound varies from $0.55 to $1.21 within the 20 fathom zone. Seaward of the 20 fathom contour the value by depth zone varies from $1.30 to $1.45 with the 31-35 fathom grouping being the highest. These data correspond to the generalized portrayal of shrimp grounds in Fig. 18. 3/

1/ Testimony of James C. Farrelly, President, Louisiana Shrimp Association, presented at August 23, 1972 OCS Public Hearing, New Orleans, Louisiana.

2/ Data from Department of Commerce, 1973, Gulf Coast Shrimp Data, Annual Summary, 1971, Current Fisheries Statistics No. 5925, National Marine Fisheries Service, NOAA.

3/ Fig. 1 is a composite portrayal of the shrimp fishery depicted in Bureau of Commercial Fisheries' Gulf of Mexico Shrimp Atlas, Circular 312, U.S. Department of the Interior, 1969.

Table 13 1971 Shrimp Catch by Depth of Water from Mobile Bay, Alabama to Sabine Lake, Louisiana. (units of thousands)

Species	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	+40		Total	Percent Species Caught
Brown	24,356	5,740	5,867	3,451	2,305	2,550	1,638	573	68		46,549	58.3
White	21,524	9,133	1,613	309	130	53	16	1	-		32,779	41.1
Pink	17	134	34	3	1	3	-	-	-		192	.2
Other	303	7	-	-	-	-	-	-	13		324	.4
Total	46,200	15,015	7,514	3,763	2,436	2,605	1,654	575	82		79,843	
Percent of Catch	57.8	18.8	9.4	4.7	3.1	3.3	2.1	0.7	0.1			
Value	25,376	16,449	8,014	4,568	3,366	3,709	2,398	822	106		64,808	
Percent of Value	39.2	25.3	12.4	7.0	5.2	5.7	3.7	1.3	.2			
Value per pound	0.55	1.10	1.07	1.21	1.38	1.42	1.45	1.43	1.30		0.81	

Reference: Department of Commerce 1973, Gulf Coast Shrimp Data, Annual Summary 1971, Current Fisheries Statistics No. 5925, NOAA XCFSA 5925 GCS, 30 p.

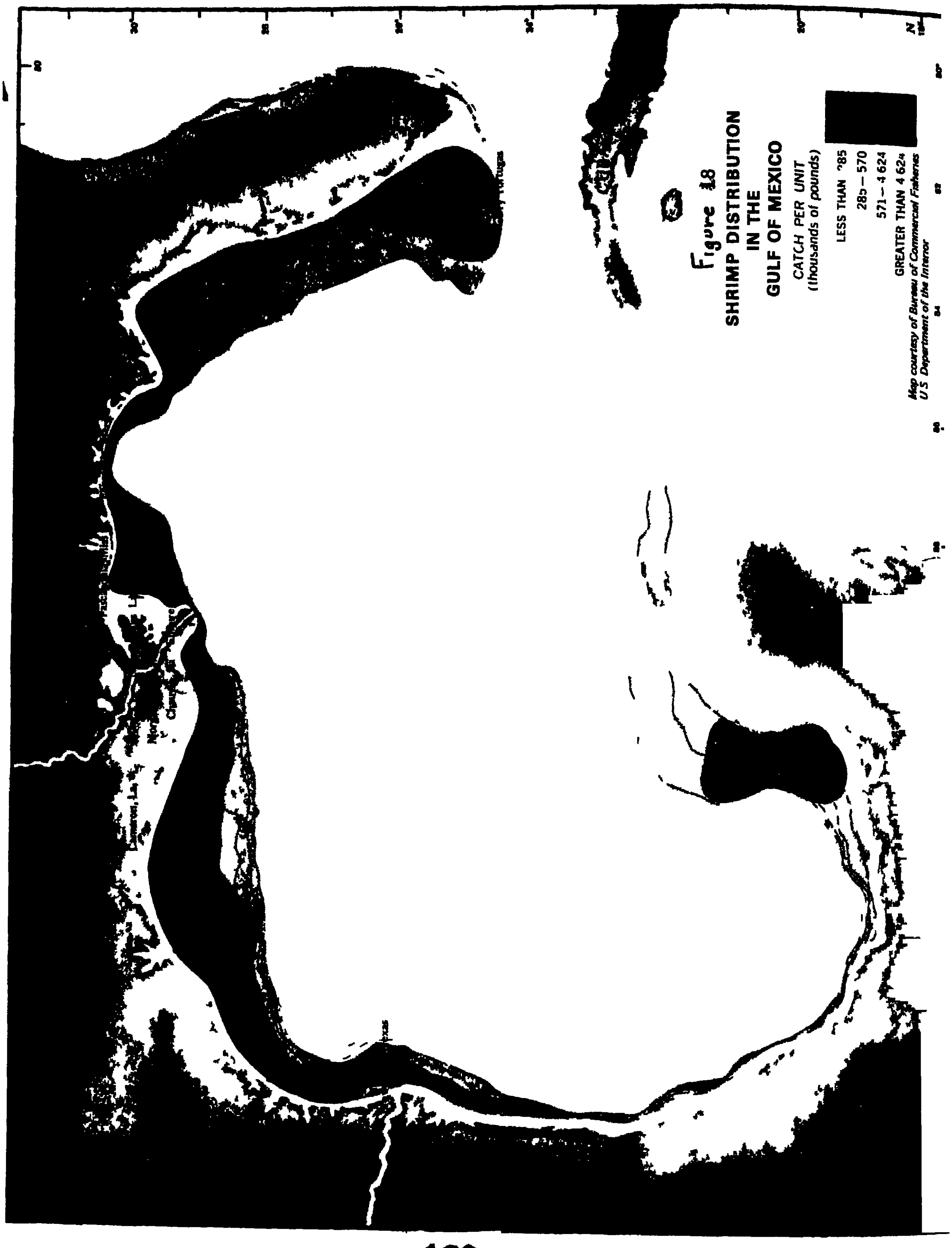


Figure 18
SHRIMP DISTRIBUTION
IN THE
GULF OF MEXICO
CATCH PER UNIT
(thousands of pounds)
LESS THAN 285
285 – 570
571 – 4 624
GREATER THAN 4 624
Map courtesy of Bureau of Commercial Fisheries
U S Department of the Interior

The BLM requires that common carrier pipelines be buried to a depth of 3 feet out to the 200 foot contour. Less than three percent of the total shrimp catch in the central Gulf is seaward of the 200 foot contour. Additional measures to require burial of pipelines seaward of the 200 foot contour for protection of the small shrimp catch taken in that area in light of its value could be considered if information is provided concerning the frequency, location, or severity of incidents involving trawling operations and unburied pipelines.

3. Loss of Catch Due to Oil Contamination

In an area of an oil spill, commercial fishing activities are inhibited in order to avoid contamination of fishing equipment, vessels and catch.

The following sections will describe effects of crude oil on some commercially important fish.

4. Impact on Commercial Fish Species

Shellfish

Numerous studies on the effects of oil on commercially important shellfish indicate that these invertebrates may both absorb, and to varying extents, clean themselves of hydrocarbons.

Oysters, Crassostrea virginica, may accumulate oil through feeding activity in a pollution zone. As the oyster feeds, it pumps water over a series of gill filaments which trap food particles such as phytoplankton. Hydrocarbons in the plankton may be incorporated in the oyster. Erdhart (1972) has found that oysters taken near the entrance to the Houston Ship Channel in Galveston Bay, Texas are contaminated with a high content of petroleum derived hydrocarbons. Because aromatic hydrocarbons are more soluble than paraffinic and napthenic hydrocarbons, the oysters most likely take up the aromatic fraction as a water solution through their gills, and as filter feeders by accumulation of particulate food matter. The author found the composition of oyster contaminants to be similar to many Texas crude oils, among them Conroe crude, Beaver Lodge crude and Lee Harrison crude.

Results from one study, Blumer et al. (1971), on more highly aromatic #2 fuel oil rather than on crude oil suggest that oil becomes part of the organism's lipid (fatty) pool. Blumer noted that the oil in specimens he observed from a Massachusetts oil spill remained relatively unchanged in composition or quantity. He reasoned that if the oil were localized within the digestive tract, a shellfish could eliminate it rapidly. But the persistence of the hydrocarbon over a time period of six months, its presence in adductor muscle tissue and the lack of further degradation of these hydrocarbons indicate that it becomes part of the organism's lipid pool.

Anderson (1973) observed oysters, Crassostrea virginica and clams, Rangia cuneata, exposed to South Louisiana crude oil and to #2 fuel oil, and came to a different conclusion. Anderson found that both aromatic and saturated hydrocarbons are released from the tissues more rapidly; maintenance in clean water for periods of 24 to 52 days was reported sufficient to cleanse the tissues of delectable levels of hydrocarbons.

Teal and Stegeman (1973) measured the amount of hydrocarbons remaining contaminated in oysters after their return to clean water and found that a concentration of 34 wg/g wet wt. persisted in a "stable" compartment. The authors concluded that, while the oysters would not retain non-biogenic (petroleum) hydrocarbons permanently, complete removal would take a "considerable amount of time."

St. Amant (1973) says that under field conditions, oily tastes generally occur in oysters when the substrate exceeds 500 ppm of hydrocarbon. He says that if the oysters are removed to unpolluted areas and allowed several months of depuration 1/, they will eventually purge themselves of oil to a point where noxious tastes are not detectable.

Scarrot (1971) has found that commercial species of scallops ingested spilled Bunker C oil. Subsequent chemical analysis revealed the

---

1/ Depuration: The process whereby a contaminated shellfish partially eliminates hydrocarbons from its system through continued exposure to clean water.

presence of Bunker C in the mantle, digestive gland, adductor mussel, and gonad.

Studies on the effects of petroleum hydrocarbons on shrimp are few. St. Amant (1973) refers to a concentration of oil of 10 ppt as being lethal to these organisms. He adds, however, that to reach this concentration under field conditions, more than 3,000 gallons of oil per acre foot of water would be required to meet the concentration. This concentration is rarely acquired except in the immediate area of a spill. St. Amant (1973) refers to Sanson (1973) who projects that in order to attain a concentration of 10 ppt of oil pollution in two of Louisiana's lakes containing 5,100,000 acre/feet of water, 15 billion gallons of oil would be needed. He claims that this is five times the rate of pollution for all the world's oceans (St. Amant, 1973).

In summary, commercially important shellfish accumulate petroleum hydrocarbons in areas of oil spills. Consumption of oysters under these conditions would introduce hydrocarbons to higher levels of the food chain. Thus state regulation of shellfish beds is important. Authors disagree on the amount of time necessary for an oyster or shellfish to cleanse itself. Estimates vary from several months to with complete depuration to six months with no depuration.

Finfish

Although fish are able to swim away from an oil spill area, they still receive some amount of contamination.

One example is given by Connel (1971) stating that the Australian mullet had a kerosene-like tainting due to the presence of kerosene-like hydrocarbons in the flesh. He found the contaminated compounds to be similar to substances isolated from river sediments. The river used by the mullet flows alongside oil refineries and associated storage and wharf facilities. Volatile hydrocarbons were found in the water adjacent to petroleum storage facilities and also in the river's estuary near a sewage fallout.

In addition, R.C. Clark (1973) cites the work of Shipton, et. al. (1970) and Vale, et al. (1970) concerning the same subject--kerosene-like tainted Australian mullets. Shipton, through gas chromatography and spectral analysis says the isolated kerosene appears to be similar to a commercial sample of kerosene. Liver examination by optical and electron microscopes revealed higher amounts of free fat than untainted samples (Vale, 1970). This condition in higher animals can be caused by petroleum distillates.

Sea-trout and plaice were found to be tainted according to taste test. These fish were caught after the Torrey Canyon incident involving the spillage of Kuwait crude oil. No chemical analysis by chemical class was reported (R. C. Clark, 1973).

Following the West Falmouth spill of September 1969, a series of sampling stations were set up for monitoring. Ten months later the first species, except for the polychaete, Capitella, were reported as returning. Among these were small flounders and killifish (Sanders, 1973).

Fish not only receive differing amounts of pollution from the water itself but through the contiminated food they eat. Blumer (1973) as stated by R. C. Clark (1973) said the hydrocarbons contained in the zooplankton upon which the basking shark fed, had passed through the digestive tract without fractionation or structural modification. These hydrocarbons were deposited in the shark's liver.

Also to be considered are the effects of oil on developing fish. Ketchum (1973) refers to Mironov's work in 1967 stating there was 100% mortality in developing flounder spawn at concentrations ranging from 1 to 100 ppm of three types of oils. There was also an increase in abnormal development following longer periods of exposure to concentrations as low as 0.01 ppm.

Despite the fact that finfish do receive contamination from the waters around them, the Louisiana fisheries statistics support the fact that there is an increase in the catch. (See Sec. II. G.) Supporting this, Mertens (1973) refers to Oppenheimer's testimony in New Orleans on Outer Continental Shelf Environmental Impact Statement Hearing, August, 1972. "Despite the presence of the oil industry in this area, the

fishing catch has risen markedly in that period and presently is greater than any other fishery in the United States." Also referenced in Mertens' article is St. Amant's comment. He expresses a similar conclusion insofar as offshore operations are concerned but cautions that operations on marshlands may have some effect. Tracts which rate an environmental impact factor greater than 50 for commercial fishing should be given particular environmental consideration.

E. Impact on Air and Water Quality

1. Impact on Air Quality

The quality of air over the sale area could be degraded by exhaust emissions of stationary power units and service vessels, and by the accidental release of oil and gas from wild wells.

The impact of exhaust emissions is unknown, but considering the small total horsepower requirements it is thought to be small.

According to one authority 1/ the average composition of natural gas as delivered to pipelines in the U.S. is:

Methane	CH_4	72.3%
Ethane	C_2H_6	14.4%
Carbon dioxide	CO_2	0.5%
Nitrogen	N_2	12.8%

(Small amounts of sulphur and other materials could also be present in some localities.)

If a wild well were not burning, obviously, the above gases would simply be released into the air. If the gas well was on fire, combustion would be essentially complete and the emissions would consist almost entirely of carbon dioxide (CO_2) and water; the nitrogen would remain as N_2 and any sulfurous gases would be oxidized to SO_2. The resulting impact would not be great.

If a wild well were releasing crude oil into the water, the resulting impact would be substantially greater. If the oil does not burn,

---

1/ Henry A. Ley, "Natural Gas", in Geology of Natural Gas, Amer. Assoc. Petrol. Geol., Tulsa, Okla., (1935) pp. 1073-1149. As cited by Levorsen (1958).

a significant amount of it will evaporate. During the Chevron, 1970 spill it was estimated that 15% of the roughly 30,000 bbl. spilled evaporated. At an average density of 310 lb./bbl., this incident would have introduced almost 14,000 lb. of hydrocarbons into the air. Some oil spills in the past have resulted in fires.

A reasonable estimate of the range of emissions, assuming complete combustion, that an oil well fire could produce per 1,000 bbl. burned, might be as follows: 1/

CO_2	:	340,000-347,000 lb.
SO_2	:	620- 34,000 lb. 2/
NO	:	660- 10,000 lb.

(As a point of reference, during the Chevron - 1970 fire and spill, the maximum spillage rate was estimated to be 1,000 bbl. per day.)

Combustion of oil would in reality be incomplete, however, and emission would contain somewhat less of the above compounds, but would include, in addition, such materials as volatilized petroleum, particulate carbon, carbon monoxide, nitrous oxide, sulphur monoxide, along with other altered or partially oxidized matter. There is no reliable way to predict in advance the relative volumes of each of these possible emissions because it would depend, among other things, upon moisture

---

1/ Values used in calculation are based on world averages for crude oil of 310 lb/bbl.; Percent content of weight is: carbon 82.2 to 87.1, sulfur - 0.1 to 5.5 nitrogen - 0.1 to 1.5 (Levorsen, 1958).

2/ SO_2 emission would be less for Gulf of Mexico crudes, which range from 0.1 to 0.5% sulfur.

content of the air, wind speed, pattern of oil spray from wild wells, number of wells involved, chemical content and physical character of the oil itself, and types of equipment and materials other than oil that might also burn.

Massive spills from wild wells are not the only source of spilled oil. Information presented in section III. B. 2. demonstrates that over 165 bbl. were spilled in 1974 as the result of almost 213 minor spills. The net result is that a small amount of spilled oil is floating somewhere on the waters of the northwestern Gulf almost continually. Concern has been expressed 1/ that the evaporation of this spilled oil may be the cause of the substantial levels of hydrocarbons which have been detected in the sea breeze coming off the Gulf. Preliminary surveys 2/ indicate that the content of reactive (smog-producing) hydrocarbons in the sea breeze between Corpus Christi and Port Arthur are at a level three times higher than the national average. At the present time there is no hard evidence as to the source of these materials.

As previously discussed, an increase in refinery capacity will add to the total emissions of oxides of nitrogen, sulphur dioxide, hydro-

---

1/ Personal communication with Mr. Kenneth Ports. Texas Air Pollution Control Service.

2/ Ibid.

carbons, carbon monoxide, and hydrogen sulfide, particularly to the atmosphere. An increase in refinery capacity and other petrochemical industries to process the predicted production resulting from this sale of 70,000 - 125,000 barrels per day would cause a small increase in emissions (see Figures 19 and 20). Oil produced as a result of this sale, however, may not necessarily create the need for increased refinery capacity and other petrochemical industries; it may replace oil that otherwise would be imported or it may take the place of oil that will not be furnished from domestic sources due to declining production or other factors.

At this time, we are unable to predict the degree of deterioration in air quality that will occur because of this proposed sale.

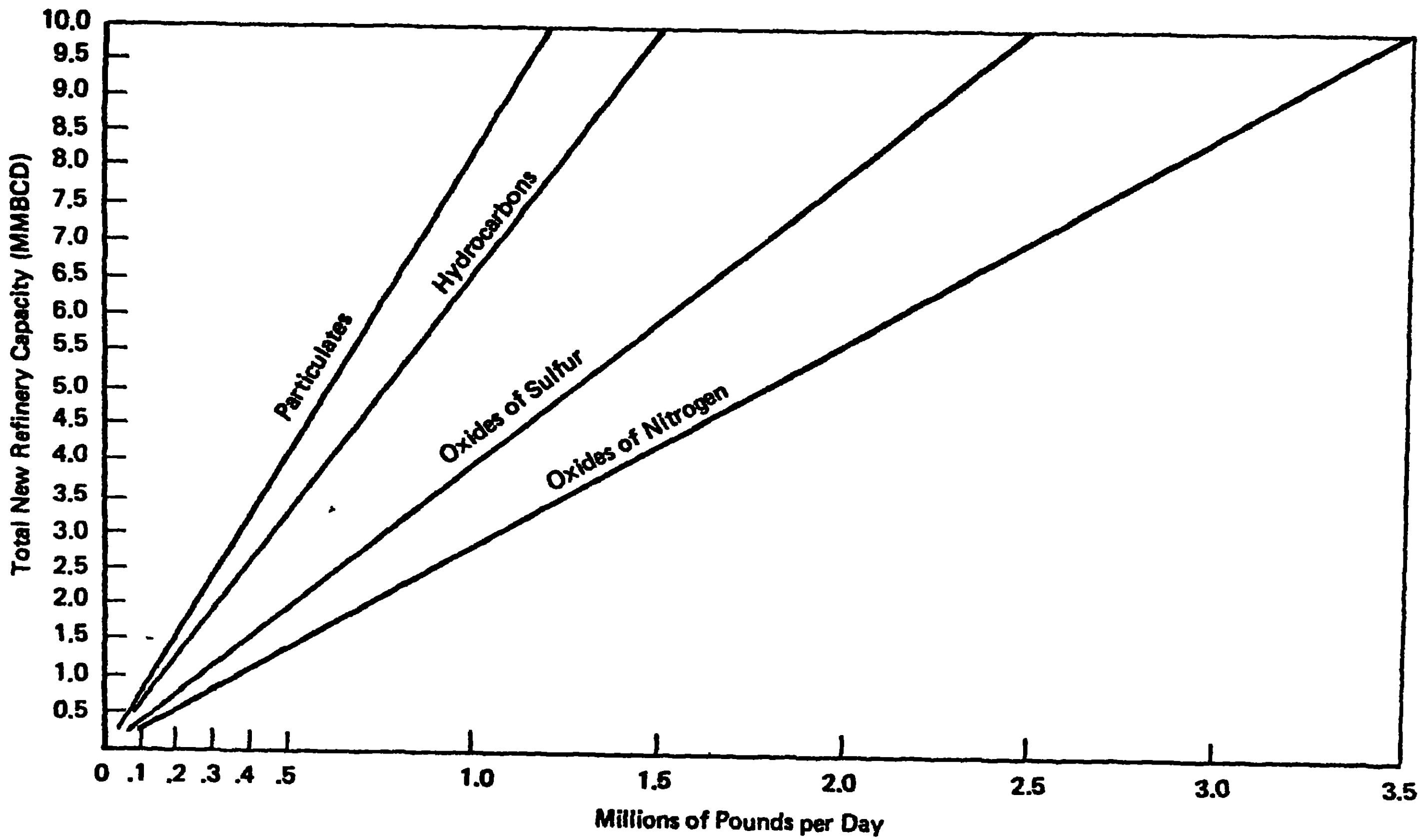


Figure 19 Potential air pollution loads from refinery operations (calculated on basis of 250 MB/calendar day unit size) (from *U. S. Dept. of the Army*, 1973).

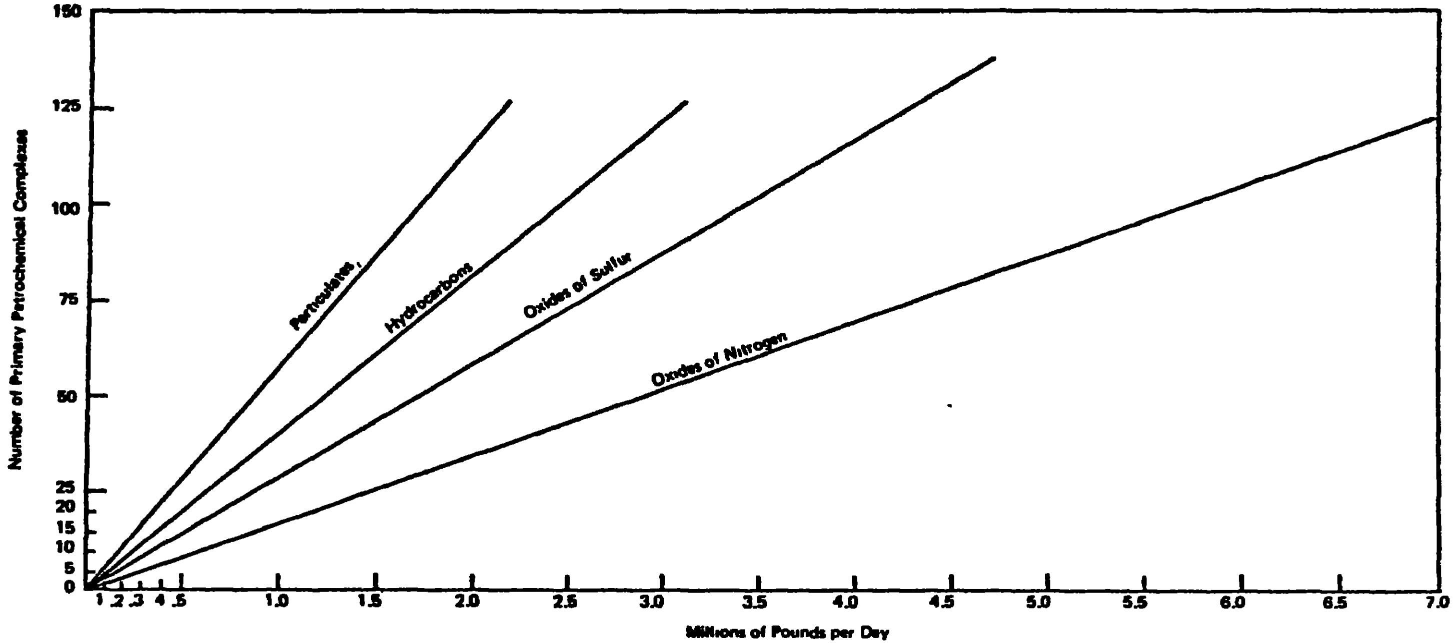


Figure 20. Potential air polution loads from petrochemical complexes (calculated on basis of one "typical" ethylene-based petrochemical complex) (from U. S. Dept. of the Army, 1973).

2. Impact on Water Quality

The natural condition of sea water may be altered and degraded in several ways during oil and gas operations.

Debris and bilge will be released into Gulf waters from the many seismic vessels, crew boats, tugs, and service and supply boats used throughout the operation. No estimate can be made of the quantities involved. They should be similar to amounts released off all types of vessels nationwide.

During drilling operations, drilling fluids and drill cuttings will be discharged into the sea. Most drill cuttings in the Gulf consist of sand and shales and therefore cause no turbidity, but settle to the bottom quite rapidly, on the order of minutes. The drill cuttings are washed prior to disposal.

It has been estimated that 1,700 barrels of cuttings and as much as 300 tons of turbidity-producing mud compounds are discharged overboard during the course of drilling an average 10,000 foot well.

The production and discharge of formation waters (oil-field brines) has been discussed earlier (section III.A.3.c). Three components or properties of formation waters contribute to water quality degradation when released into the sea. One is the small amount of entrained liquid hydrocarbon. There are some locations disposing of formation water where the treatment equipment puts out an effluent with less than 25 ppm oil content, but the facts also show that this control

is not being accomplished across the board on a continuing basis. Many other locations only manage to meet the requirements of OCS Order No. 8, releasing waters with entrained oil averaging less than 50 ppm. The second property of formation water that degrades water quality is its high concentration of dissolved mineral salts. This value ranged from 61,552 mg/1 to 270,400 mg/1 in 76 samples from the OCS off Louisiana. This contrasts sharply to the average sea water salinity of 35,000 mg/1. The third degrading property results from the fact that formation waters are devoid of dissolved oxygen. Current production of formation waters from all Louisiana OCS operations is 605,000 bbl/day; 305,000 bbl/day is transported to shore.

Water quality could be further degraded as the result of accidental oil spills. It is estimated in Sec. III.B.2. that based on the rate of oil spillage, as much as 2,612 bbl. per year could be spilled from tracts included in this sale. In addition, approximately 260 bbl. per year will likely be released through minor spillage. Part of this spilled oil would be removed by clean-up operation and some would evaporate, but the largest proportion would probably be dispersed into the waters of the Gulf.

Another source of water quality degradation is the resuspension of sediment during pipeline construction and burial. This operation was discussed in section III.A.4.a. The jetting away of the substrate

from beneath the pipeline will result in creating a plume of turbidity trailing away from the operations in the direction of the current. The plume can reach proportions of several yards wide and hundreds of yards long if the substrate is exceptionally muddy. The duration appears to be on the order of several hours at a given location.

Water quality in some areas of Louisiana is affected by effluents from oil refineries and petrochemical plants. Although production from this sale will not require an expansion of refinery capacity in the area, it will be refined in the area along with production from other non-OCS sources. In this manner, production from this sale will contribute to the continuation of refining activity in the region and its resultant effects on water quality. Effluent discharges could increase the total dissolved solids, oil, and biological oxygen demand (Figures 21 and 22). These discharges, however, must meet existing local, State, and Federal anti-pollution standards.

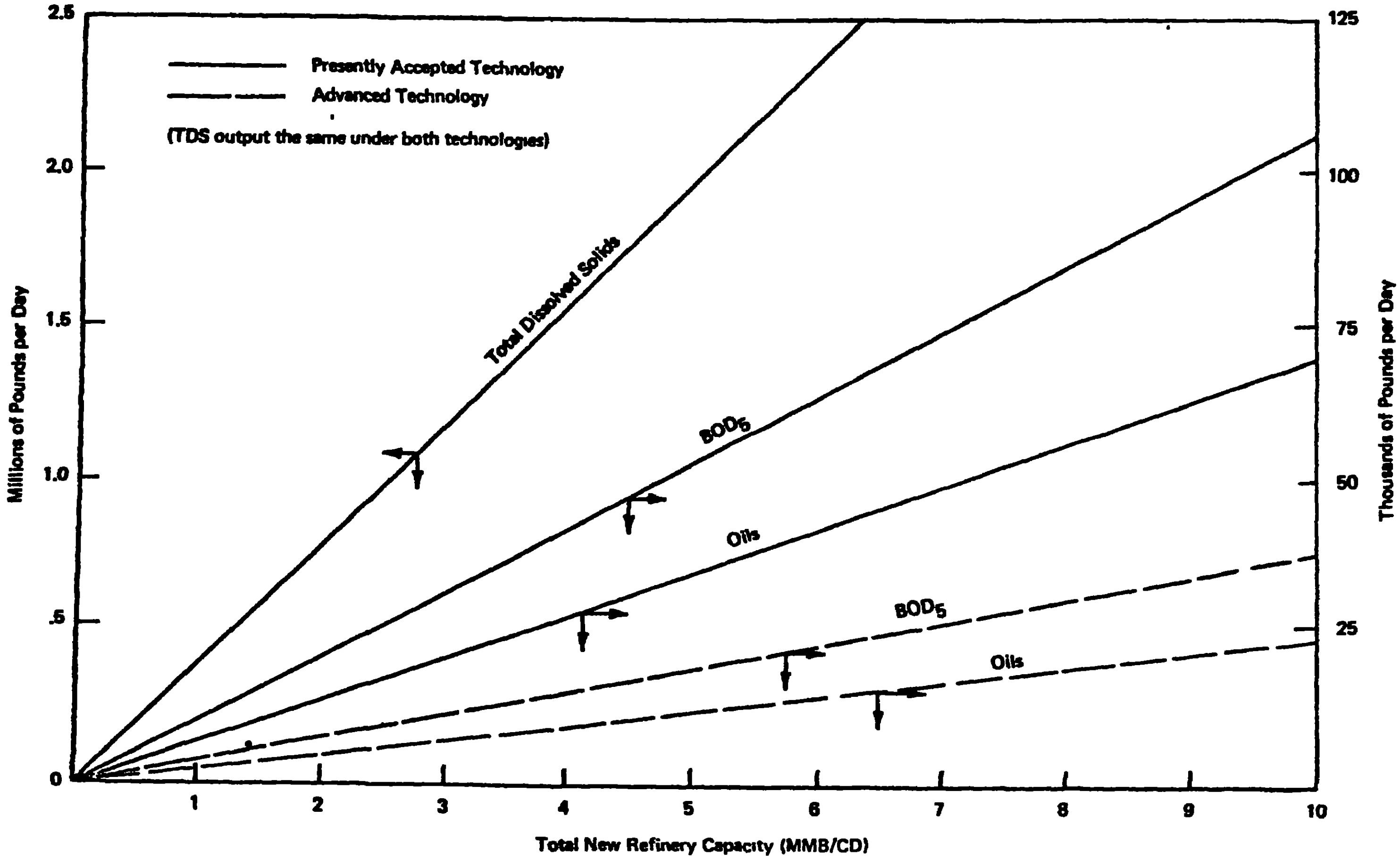


Figure 21 Potential water polution loads from new refinery operations in terms of million per calendar day (from U. S. Department of Army, 1973)

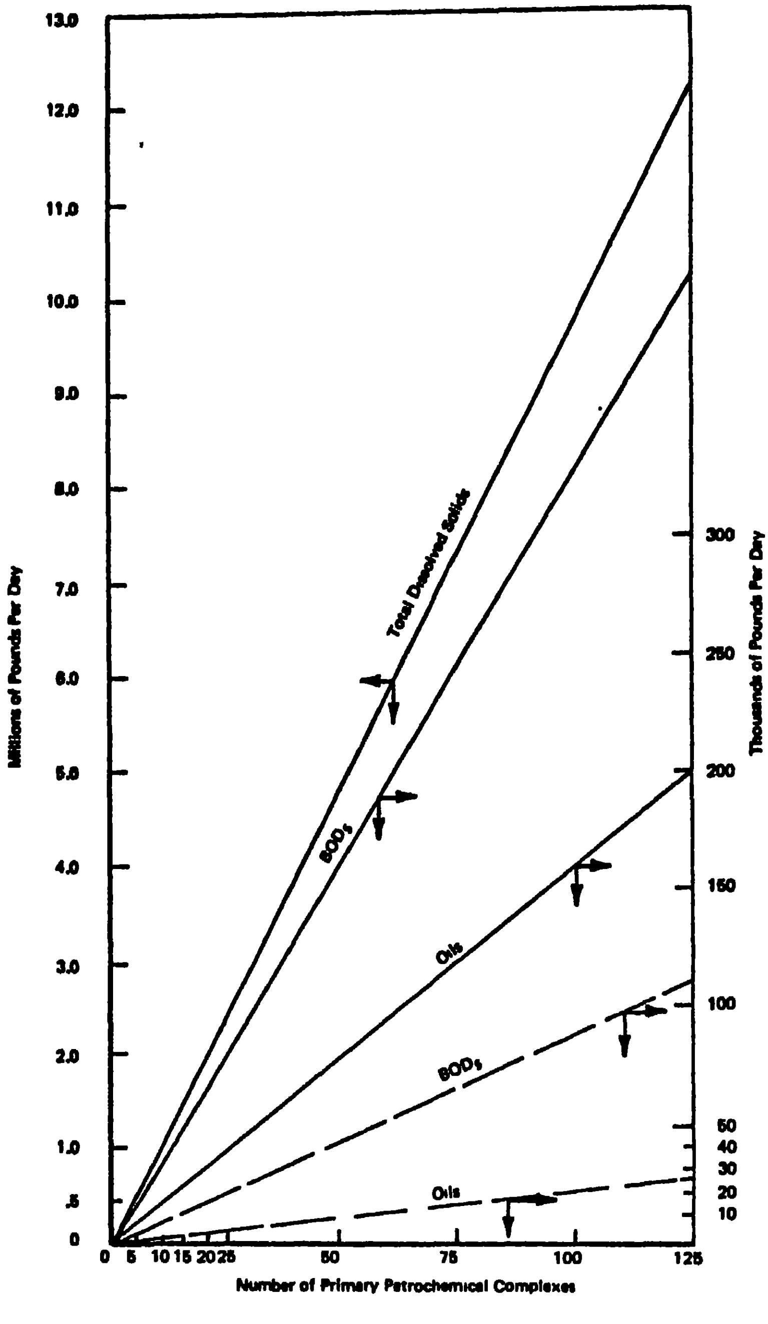


Figure 22 Potential water pollution loads from petrochemical complexes (Calculated on basis of one "typical" ethylene-based complex (from U. S. Department of Army, 1973)

F. Conflict with Ship Traffic and Navigation

In seas adjacent to the United States, including the Gulf of Mexico, safety fairways have been established for the safe passage of vessels enroute to, or from, U.S. ports. However, an unknown number of ships do not use these fairways, greatly increasing the possibility for a collision with drilling rigs, permanent platforms, and their attendant vessels. Impacts which could result include loss of human life, spill of oil, release of debris including part of, or the entire drilling rigs, and the ship, if it sinks. The contents of the ship's cargo could pose a serious threat to the environment if it includes toxic materials such as chemicals, crude oil, or refinery products. Statistics on ship-platform collisions were given in section IV.A.2.d. In addition, current Coast Guard regulations concerning lighting and fog alarms on structures are summarized in Attachment M.

Floating trash accidentally lost off platforms also constitutes a hazard to boats. Damaging collisions can result between small fast boats and floating drums, cans, and wood. The screws of all sizes of motor boats and vessels can be fouled on floating plastic sheeting and plastic or nylon ropes. The extent of this problem is unknown. All oil production from this proposed sale will be moved ashore via pipelines.

G. Conflict with Military Uses of the Continental Shelf

The Gulf of Mexico is used rather extensively by the Navy and Air Force for conducting military training and research operations. These current activities consist of missile testing, ordnance testing, drone recovery operations, and electronic counter measure (ECM) activities by the Air Force. Mine research activities are conducted by the Department of the Navy. Most of this activity takes place in areas designated for these purposes. However, live ordnance testing by the Air Force occasionally involves emergency release of ordnance outside designated bombing areas. These ordnances range from small munitions to 1200-pound bombs. The possibility of occurrence of unexploded munitions on the ocean floor in the proposed lease sale is extremely remote.

H. Impact on Recreational, Historical and Archeological, Aesthetic, and Conservation Resources

1. Beach and Shoreline Recreation

Recreation activities in beach and shoreline areas can receive impacts from pipeline construction onshore, from oil spills, and from the placement of onshore facilities, such as production terminals or transfer facilities, should they be located in or near a recreation area.

There is a possibility that one new pipeline may be brought ashore as a result of this sale. If it crosses a beach area used for recreation there will be an impact. The area of beach distrubed by pipeline construction would be fairly small (30 feet wide) and the first high tides following burial of the pipeline would serve to restore the beach terrain. Restoration of the beach ridge would take longer, most likely requiring a storm tide or high winds to obliterate the effects of excavation. Physical interference, then, with recreational activities will be minimal and short-lived.

If production terminal or transfer facilities are located in or near a beach or other area used for recreation, there will be an adverse impact from disruption during the construction phase and elimination of anywhere from 20 to 100 acres per terminal plant for recreational uses. This latter impact would be long-term and restoration of the area, if attempted at all, would have to await depletion of the offshore production which the plant would be designed to serve. These

impacts may tend to diminish quality of the area for recreational enjoyment.

Water sports, such as swimming, diving, spearfishing, underwater photography, fishing for finfish and shellfish, boating and water skiing would also be directly affected by an oil spill.

Other marine related activities such as beachcombing, shell collecting, painting, shoreline nature study, camping and sunbathing would be made much less attractive for an indeterminate period where an oil spill had coated a beach.

Removal of oil from beaches used for recreation in the area under consideration would probably involve removal of the contaminated sand and possibly, replacement of the sand if needed. The time period for clean-up in this case would depend on the extent of beach affected. Recreational use of the area would be precluded during the time that oil covered the beach and during the clean-up process also.

The impacts of an oil spill discussed above would be more keenly felt if the recreation area involved is intensively used or considered to have unique or outstanding recreational values such as many of the popular recreation areas along the eastern Gulf coast. Not only would the impact be felt by the recreational users of the area, but, consequently, the community or businesses whose economic well-being depends on use of their recreational resources by tourists would be affected. If an oil spill were to cover outstanding recreational beaches during

the height of the recreational season, the impact could be expected to be more severe, in that residents and tourists would not be attracted to a beach area contaminated by oil or undergoing a clean-up process, and there would be a resultant economic loss.

2. Aesthetic and Scenic Values

If air quality permits unlimited visibility, some portion of a one hundred foot structure can be seen from the beach if it is located 17 miles or less from shore. Some people consider the sight of offshore equipment aesthetically unpleasant. Seventy-six of the 295 tracts included in this proposal are located at distances varying from 4 to 17 miles from shore. The shore in this case being that shoreward of West Cameron, East Cameron, Vermillion, South Marsh Island North Addition, Eugene Island, Ship Shoal, South Timbalier, West Delta, South Pass, South Pass-South and East Addition, Main Pass, Main Pass-South and East Addition, and Mobile South No. 2 areas.

It is likely that some structures resulting from this sale will be visible from the recreational beach areas in western Louisiana, Isles Dernieres, Grand Isle, and Breton, Delta, Pass a Loutre, Wisner, Marsh Island, Paul J. Rainey, and Rockefeller wildlife refuges or management areas. The visibility of these structures may be considered to be an adverse impact on the aesthetic values these areas by some.

Any floating material such as debris or oil that is cast up on the beach or washed into a bay would constitute an impact upon the aesthetic values for users or owners of the area.

Even after burial of a pipeline, the scars will cause an impact on the aesthetic values of the beach and associated dunes and sand flats. It is our estimation that the impact will endure for at least a year, until sand has been redistributed by wind, tides, and rain, and another growing season brings about revegetation.

Revegetation of dunes crossed by pipelines would reduce adverse effects from an aesthetic and scenic viewpoint and would decrease the chance of destruction of the dunes by erosion. It is not, however, within the Federal Government's authority to require the revegetation of affected dunes unless they are on Federal lands. State or local authorities may require revegetation of dunes disrupted by pipeline installations.

In marsh areas where it is impossible to backfill canals or ditches because of the unconsolidated nature of the substrate, there will be an adverse impact on aesthetic values if any pipelines are constructed. The laying of a pipeline in these areas would result in an open canal or ditch through the marsh. However, this would be an add-on effect since there are at present numerous canals or ditches of this sort.

There will be an adverse impact on aesthetic and scenic values resulting from construction of onshore terminal and product storage facilities, and pumping stations if these facilities are located in areas valued for their natural or scenic qualities. Some people will find the visual impact of these facilities aesthetically displeasing. There also may be noise pollution associated with vehicular traffic to, and from, these facilities and noise pollution resulting from pumping stations

that would reduce the serene and natural qualities of an aesthetically enjoyable area.

3. Historical or Archeological Sites and Objects

Impacts on these could stem from two sources. During an oil spill, any objects coated with oil would obviously be rendered less useful and valuable and may not survive cleaning operations. In addition, porous items such as wood, pottery, or shell may be internally contaminated with oil and this might interfere with carbon dating procedures.

During pipeline burial operations or construction of terminal, storage, or pumping facilities, as yet undiscovered archeological sites or objects and shipwrecks may be damaged or destroyed. Normal pipeline route survey procedures usually include a magnetometer survey. In this way, all larger ferrous objects, including objects of historic or archeological value, are detected and avoided or investigated prior to actual laying operations. This survey would not reveal the presence of non-ferrous objects, however. Therefore, it is likely that sites containing archeological evidence of cultures which did not make use of metal, i.e., the older, less well-known cultures, would not be detected by this method.

Special surveys of onshore facility site locations and pipeline routes would have to be taken before any assurance that sites and objects of historical or archeological interest might not be destroyed or damaged.

Pipeline burial operations have the potential for damage or accidental destruction of as yet undiscovered sites which may be important to the understanding of prehistoric inhabitants of the area. The scope of the impact, and its probability of occurrence, is not possible to determine at this time. The impact may be mitigated to some degree if the appropriate state authorities are consulted as to the exact locations of known archeological sites or potential locations for undiscovered sites before any construction or pipeline burial is undertaken. See Section IV. D. 1. for a stipulation which will be applied to any lease and BLM-permitting pipelines resulting from this proposed sale for the protection of archeological, architectural, or historical values.

4. Conservation Resources

Included under this heading are the state and Federal wildlife refuges and management areas, aquatic preserves, natural landmarks, wildlife areas, and any other areas formally set aside for conservation of their natural values. There are a number of areas of this type adjacent to the coastline of Louisiana (Vol. 1, Sec. II.G.2.).

The impacts of oil spills and pipeline and onshore facility construction on biota, air and water quality, beaches, etc., have been discussed previously. Should an oil spill occur in a conservation area, or should pipeline and onshore facility construction occur in one of these areas, the impacts discussed above will apply. In the event that impacts discussed previously do occur in a conservation area,

the impact will not only be on the air and water quality, beaches, biota, etc., the impact will also be on the effort to preserve or protect a unique, representative or otherwise significant natural value. The matrix analysis identifies those tracts which pose environmenta hazards to these areas.

In addition, any adverse impact on biota in these areas may be considered particularly severe in that these areas are reserved specifically for the preservation or management of wildlife species, some of which are considered endangered or threatened.

5. Sport Fishing and Recreational Boating

Although we have no conclusive evidence, it is our opinion that a major oil spill would affect fishing adversely. Boat fishermen would not want to soil their boats by fishing in the vicinity of an oil slick and neither boat nor surf fishermen would want to keep fish that had been coated or contaminated with oil. Therefore, sport fishing would be curtailed in the vicinity and for the duration of the spill incident. From the standpoint of intensity of use by fishermen, an oil spill's impact on sport fishing would be felt most severely in Sub-basins I and IV (see Sect. II.G.2.).

We have received extensive testimony and evidence that overall, oil and gas operations have a favorable impact on sport fishing activities. The favorable impact is the result of sports fish population enhancement due to the artificial reef effect of offshore platforms. In the open sea, offshore platforms provide both food and cover in areas that

are largely devoid of these essentials. Myriad forms of micro-organisms in the water drift by these structures and attach themselves, soon encrusting all exposed surfaces on the platform. The average platform in 150 feet of water provides 90,000 square feet of hard surface for encrusting organisms. 1/ Hard substrate is necessary for encrusting organisms such as barnacles, corals, mussels, hydroids, and other invertebrate organisms which serve as links in the food chain. Randall (1963) has stated that artificial reefs provide protection, food sources, spawning sites, and spatial orientation markers for fishes. The same author found that artificial reefs attract available fish from surrounding waters, and increase the size of some populations by providing additional protected areas and food for both young and adults.

It has been suggested (Bureau of Outdoor Recreation comments on the draft statement) that minor design modifications on fabricated rig structures be added to facilitate sport fishing and scuba diving.

Recreational boating not involving sport fishing would also be adversely affected by an oil spill. Persons desiring to use their boats for sightseeing or travelling would not wish to soil their boats in an oil slick. Should a slick come ashore in a marina, there would be an economic loss involved in the cleanup of boats and dock facilities.

6. Impact on Endangered and Threatened Wildlife

There are numerous species of endangered and threatened animals shoreward of the proposed sale area. There are several reasons for species becoming endangered or threatened; prominant among these reasons is the loss of suitable habitat; although overhunting has also been a cause. Any activity or accident (such as an oil spill) resulting from this proposed sale which would further limit the suitable habitat for an endangered or threatened species, or actually reduce the numbers would increase the danger to the species' survival.

Endangered species in the sale area which are designated in the Department of the Interior publication United States List of Endangered Fauna (May, 1974) are listed in Table 14 below. Species included in the publication Threatened Wildlife of the United States (March, 1973) are also listed in Table 14. Information for this listing was compiled by the Office of Endangered Species and International Activities, Bureau of Sport Fisheries and Wildlife.

These animals are either endangered, threatened, peripheral, or status undetermined. The significance of the classification differs according to the Office of Endangered Species designation of the status of the animal, the amount of protection given by Federal law and the amount of information submitted to the Office of Endangered Species which is included in the 1973 publication.

The Endangered Species Act of 1973 (P. L. 93-205; 87 Stat. 884) seeks:

> "...to provide a means whereby the ecosystems upon which live endangered species, and threatened species depend may be conserved to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions..."

Threatened refers to species "threatened" with extinction which are very often included in the Endangered listing published in the Federal Register. However, some "threatened" species are not yet considered endangered. A peripheral species or subspecies is one whose occurrence in the United States is at the edge of its natural range and which is threatened with extinction within the United States although not in its range as a whole. Special attention is necessary to assure retention in our Nation's fauna.

A status-undetermined species or subspecies is one that has been suggested as possibly threatened with extinction but about which there is not enough information to determine its status.

Table 14 Endangered (E), Threatened (T), Peripheral (P) or Status Undetermined (SU) Animals in Louisiana

Office of Endangered Species, U.S. Dept. of Interior, 1974

Reptiles

American alligator	Alligator mississippiensis	E
Atlantic Ridley Turtle	Lepidochelys kempii	E
Hawksbill Turtle	Ertmochelys imbricato	E
Leatherback Turtle	Dermochelys corianeio	E
Green Turtle	Chelonia mydas	T

Birds

Arctic peregrin falcon	Falco peregrinus tundrius	E
Brown Pelican	Pelecanus occidentalis carolinensis	E
Bachman's Warbler	Vermivora backmanii	E
Southern Bald Eagle	Haliaeetus leucocephalus	E
	leucocephalus	E
Woodpecker, Ivory-billed	Campephilus principalis	E
Woodpecker, Red Cockaded	Dendrocopus barealis	E
Curlew, Eskimo	Numenius barealis	E
Roseate Spoonbill	Ajaia ajaja	P
Wood Ibis	Mycteria americana	P
Eastern Pigeon Hawk	Falco columbarium columbarius	P
Northern Long-Billed Curlew	Numenius americanus parvus	P

Mammals

Blue Whale	Balaenoptera musculus	E
Finback Whale	Baleanoptera physalus	E
Humpback Whale	Megaptera novaeangliae	E
Sei Whale	Baleanoptera borealis	E
Sperm Whale	Physeter catodon	E
Red Wolf	Canis rufus	T
Louisiana vole	Microtus ludovicianus	SU

I. Secondary Impacts

1. Induced Industrialization in the Coastal Zone

Large petroleum-related industries are already well established in Louisiana and Texas. Production platforms, exploratory rigs, pipeline construction equipment, and other equipment, both new and used, needed for development in this proposed sale are expected to come from these areas. Likewise, existing refinery capacity in Louisiana and Texas will be used for processing production expected from the proposed OCS sale #36.

There are three possible results from this sale:

(1) Production from this sale will offset in full or in part declining production from onshore and offshore areas.

(2) Production from this sale will enable an equivalent reduction of oil imports.

(3) Production from this sale will require an expansion of existing refinery capacity.

There is no way of predicting at this time which of the above three events will occur. Possibility (1), however, seems the most likely to occur given the estimated daily production anticipated as a result of Louisiana OCS sale #36. Possibilities numbers (1) and (2) would not increase present levels of environmental impacts

associated with existing refineries. Possibilty number (3), however, would have an incremental, add-on environmental impact as a result of an increase in refinery capacity and throughput. This would result in additional increments of sources of air and water pollution. Additional but unknown quantities of particulate, SO_x, NO_x, hydrocarbon, aldehyde and ammonia emissions would result from increased refinery throughput. Also, additional increments of water pollution from refineries discharging waste water could result. Such pollutants as suspended solids, total dissolved solids, oil, ammonia, chromium, phenol, sulfides and increased BOD and COD would result from increased refinery capacity. It is not possible at this time to quantify the add-on increases of air and water pollutants. In any event, all emissions and pollutants would have to be within levels required by appropriate State or Federal standards.

A number of support facilities and activities will be required as a result of this proposed sale. Some of these are identified below.

(1) Production, Storage and Pumping Transfer Terminals

According to Geological Survey estimates production from this sale will require from zero to five new terminals and as many as two new storage facilities. Preliminary estimates from

industry indicate that should rapid development of tracts offered in the previous OCS oil and gas lease sale offshore Louisiana and this proposed sale occur, there may be a need for one new pipeline to come ashore resulting in one new terminal facility. However, according to industry, it is quite possible that existing facilities will be able to handle production from this sale.

These terminals serve as collecting points for oil which is brought to shore by pipelines. Oil that has not been treated on the production platform is treated to remove sludge and sand and to separate, treat and dispose of associated waste water. Terminals of this type usually range from 30,000 to 100,000 bbl./day capacity and have a 2 to 3 day production storage capacity. They may occupy from 20 to 40 acres of land depending on the amount of production they process each day. If the oil is to be transported to a refinery by pipeline then a pumping transfer facility may be required. A pumping transfer facility may serve as a receiving point for one or more intermediate production terminals. It will usually have a 4-5 day production storage capacity with storage tanks ranging in size from 50,000 to 200,000 bbl. each depending on production levels and number of producing terminals which it serves. Large pumps are used to move the oil from the transfer facility to refineries by pipeline.

(2) Support Facilities and Activities

It is estimated that oil field supply companies who provide necessary field equipment for both drilling and producing operations would use established storage and warehouse facilities at strategic locations as a result of this proposed sale. It could be expected, based on past experience, that utilization of existing facilities on short-term leases (i.e., 3-5 years) in already developed areas would be undertaken wherever possible. Each additional storage or warehouse facility would occupy from 3 to 4 acres.

The environmental effects associated with onshore support facilities are not likely to increase as a result of this proposed sale. Industry representatives have indicated that every effort will be made to locate any additional facilities in areas of existing industrial development, to utilize existing wharf facilities, and in general to locate in areas where access to land, sea and air facilities are presently available for industrial purposes. All onshore developments resulting from this proposed sale, where appropriate State or local government regulations apply, will be subject to those regulations and standards.

2. Economic Effects

Offshore production resulting from OCS sales historically has resulted in the need for increased onshore facilities for the transporting, storing and processing of gas and crude oil, as well as for ancillary petrochemical industries. The direct and indirect, primary and secondary socio-economic stresses, impacts and responses, both long-term and short-term, are often highly sensitive to specific areas of production and levels of production, and have involved a significant portion of the impact consideration.

Throughout this statement, an assumption has been used as the basis for assessing the impact on the "natural" environment. For consistency, the "socio-economic" impacts will be based on the same assumption (i.e., that offshore production resulting from this sale will be transported to existing refinery facilities in Louisiana, or in Texas, or transported through intermediate facilities to these same refineries. This assumption permits the conclusion that onshore sensitivity or impact, will be a function of utilizing or expanding an existing infrastructure.

Historically, the Gulf coast has been a surplus producer of crude oil and petroleum products. This surplus has been shipped to other regions in the U.S. to meet their demands. Production records for the Federal OCS operations along the Gulf coast indicate that production began declining in the summer of 1972. The production resulting from this sale probably will serve to maintain existing levels of offshore produc-

tion, rather than act as an increment. Therefore, the production from this sale, in itself, will not introduce a significantly greater magnitude, or new type of socio-economic impact or stress for much of the onshore areas directly landward of the proposed production areas.

The OBERS projections (Attachment G) show only slight increases in employment for the petroleum and related industries for all BEA Economic Areas possibly affected by the La. #36 sale. The earnings for the industry, however, are disproportionately greater than the increases in employment because of the greatly increased input per employee anticipated between 1970 and 2020.

This greatly increased refinery capacity and output for the entire Gulf in the face of a projected near term peak, and then decrease in the offshore supply, implies the processing of crude oil imported into the area. The impact of this sale cannot be treated in isolation from such externalities, i.e., other projects which have parallel socio-economic impacts. Of special significance is the potential importation of crude oil for processing in the Gulf region, as supported by the following excerpt: ". . . current demands placed on the region by P.A.D. Districts I and II have increased total demands for District III (The Gulf Coast) crude oil products to the point where importation of foreign crude oil has become necessary to supplement domestic production. Assuming District III is to continue supplying crude oil and products to these regions and continue meeting

its own needs, foreign crude oil imports are projected to reach approximately 3,500,000 bcd in 1980, and 11,400,000 bcd in 2000. The coastal refinery capacity is projected to increase from the present 4,818,000 bcd to approximately 9,062,000 bcd and 15,175,000 bcd in 1980 and 2000, respectively." 1/

The socio-economic impacts of this sale will relate most significantly to the location and magnitude of the refining industry and the chemical and allied products industries. It will also relate, but less significantly because of the smaller magnitude of development, to the requirements for other various onshore support facilities.

Given the two assumptions stated previously (that offshore production from this sale would be transported directly to existing refineries in Louisiana, or Texas, or transshipped through terminal facilities to these refineries), it is likely that BEA Economic Areas 138, 139, New Orleans and Lake Charles Louisiana will be the primary areas to be effected. It is also possible BEA Area 140 (Beaumont-Port Arthur-Orange, Texas) and 141 (Houston, Texas) could be effected.

The onshore response to any developmental pressures, either from this sale or other externalities, or both in combination, is presently the function of State and local policies regarding economic development

1/ Unpublished report prepared by the Dept. of the Army, Lower Mississippi Valley Division, Corps of Engineers, Vickburg, Miss., entitled "Report on Deepwater Port Facilities, Texas, Louisiana, Mississippi, Alabama, and Florida".

and land use. The brunt of economic impact will be felt almost entirely by Louisiana as a result of this sale. Some economic impact may extend as far West as Houston (Attachment G) although the impact would not be sufficient to warrant detailed examination.

The economic impact on Louisiana of holding LA. #36 sale is not as significant as the adverse impact of <u>not</u> holding the sale. Over 20% of the total wages earned by Louisiana citizens falls within the following three catagories. 1/

CATEGORY I
(Mining)

<u>Jobs which exist only to the extent that oil and gas exploration and production occurs in Louisiana.</u>

As of June, 1972 there were 47,800 persons employed in the mining of oil and gas in Louisiana, with average earnings of $10,400. The annual payroll approximates $500,000,000, which represents over 6% of all Louisiana wages and salaries.

CATEGORY II
(Manufacturing Feed Stock)

<u>Manufacturing operations which depend upon oil and gas as a feed stock.</u> While this feed stock could be imported from other areas, the increased transportation cost would reduce Louisiana's ability to compete with other facilities located close to the marketplace or the oil and/or gas supply.

1/ Prepared by the Research Division, Louisiana Dept. of Commerce and Industry.

No. Workers	Product	Earnings*	Annual Payroll
10,375	Industrial organic chemicals	$10,946	$113,546,750
3,312	Plastic materials & Synthetics	10,946	36,253,152
1,197	Carbon black	10,946	13,102,362
9,700	Petroleum refining	11,778	114,246,600
1,574	Oil field machinery	7,750	12,198,500
26,158	*Average Annual Earnings		$289,365,364

This category accounts for 4% of the total wages and salaries paid in Louisi-na.

CATEGORY III
(Oil and Gas Markets)

Industries which depend upon the Louisiana oil and gas industry to buy all or part of their goods and/or services. Any reduction in Louisiana oil and gas activity can be expected to significantly affect these industries.

No. Workers	Industry	Earnings*	Annual Payroll
61,300	Transportation	$ 8,445 (est)	$517,678,500
19,300	Manufacturing & Repairing transportation equipment	8,432	161,894,400
9,800	Fabricated metal products manufacturing	8,315	81,487,000
14,272	Wholesale trade machinery equipment and supplies	8-9,000	125,000,000
104,672			$886,059,900

This category accounts for 11% of the total wages and salaries paid in Louisiana.

Thus, over 20% of the total wages earned by Louisiana citizens falls within these categories of total or heavy dependence upon the oil and gas industry.

NOTE: No attempt was made to assess the indirect impact on retail sales services, State and local taxes, etc.

Apart from state statistics as a whole, attention should be paid to the economic importance of the oil and gas industry to coastal Louisiana parishes.

Within the United States there is an average ratio of thirty manufacturing jobs for each mining job.

Coastal Louisiana during the years of unrestricted development of offshore oil and gas has become quite dependent upon mining as its primary industry, as illustrated by the following statistics: 1/

Parish	Mining No. Employed	Manufacturing No. Employed
Cameron	1,331	236
Iberia	1,949	1,780
Lafayette	5,575	2,000
Lafourche	1,070	1,689
Plaquemines	4,866	925
St. Mary	3,414	2,804

1/ Prepared by the Research Division, Louisiana Department of Commerce and Industry.

Parish	Mining No. Employed		Manufacturing No. Employed	
Terrebonne	3,560		2,805	
Vermilion	1,023	22,788	693	12,932

Over 40% of the mining jobs in Louisiana are concentrated in the eight coastal parishes listed above.

In a similar study on the economic impact of the Louisiana offshore oil industry on the State of Louisiana by the American Petroleum Institute (1971), the following results were presented.

SUMMARY OF RESULTS 1/

1. People directly and indirectly employed as a result of the existence of the offshore oil industry.

   a. Direct

      i. Number 38,000
      ii. Annual Income $381,000,000

   b. Indirect

      i. Number 76,000
      ii. Annual Income $418,000,000

2. Capital expended to find, develop, produce transport and process offshore oil and gas.

   a. Period 1948-1971 $9,390,000,000
   b. 1971 807,000,000

3. Capital expended which stayed within the State of Louisiana to find, develop, produce, transport and process offshore oil and gas.

   a. Period 1948-1971 $5,500,000,000
   b. 1971 482,000,000

1/ For a detailed description of the approach and details of development of data see "Study: The Economic Impact of the Louisiana Offshore Oil Industry on the State of Louisiana." American Petroleum Institute, Committees on Exploration, Subcommittee on Production.

4. Operating and maintenance expenses for producing, transporting, and processing offshore oil and gas.

a.	Period 1948-1971	$2,600,000,000
b.	1971	376,000,000

5. Operating and maintenance expenses which stayed within the State of Louisiana for producing, transporting, and processing offshore oil and gas.

a.	Period 1948-1971	$2,080,000,000
b.	1971	301,000,000

6. Comulative industry direct impact on the economy of Louisiana (3 plus 5).

a.	Period 1948-1971	$7,580,000,000
b.	1971	783,000,000

7. Louisiana payroll from indirect employment as a result of offshore oil industry. (See 1 above)

a.	Period 1948-1971	$4,020,000,000
b.	1971	418,000,000

8. Total direct and indirect impact of offshore oil industry on State of Louisiana. (6 plus 7)

a.	Period 1948-1971	$11,600,000,000
b.	1971	1,201,000,000

SUMMARY OF ESTIMATES

1. Total oil and gas producing company personnel employed in the Louisiana oil and gas offshore industry

8,000

2. Annual payroll for these 8,000 people.

$96,000,000

3. Total oil and gas service personnel directly employed in the Louisiana oil and gas offshore industry.

30,000

4. Annual payroll for these 30,000 people.

$285,000,000

5. Total personnel employed as an indirect effect of the 38,000 identified industry employees.

76,000

6. Annual payroll of these 76,000 people.

$418,000,000

7. Total Louisiana employment contributed by Louisiana offshore oil industry.

114,000

8. Total annual payroll of these 114,000 people.

$799,000,000

9. Capital expenditures by the oil and gas producing companies offshore Louisiana.

a. Cumulative (1948-1971)	$8,000,000,000
b. 1971	774,000,000
c. Portion of cumulative expenditures which stayed in Louisian	4,800,000,000
d. Portion of 1971 expenditures which stayed in Louisiana	464,000,000

10. Oil and gas producing companies Louisiana offshore operating and maintenance expenses.

a. Cumulative (1948-1971)	$2,370,000,000
b. 1971	356,000,000
c. Portion of cumulative expenses which stayed in Louisiana	1,900,000,000
d. Portion of 1971 expenses which stayed in Louisiana	285,000,000

11. Capital expenditures by oil and gas pipeline companies offshore Louisiana.

a.	Cumulative (1948-1971)	$850,000,000
b.	1971	23,000,000
c.	Portion of cumulative expenditures which stayed in Louisiana	510,000,000
d.	Portion of 1971 expenditures which stayed in Louisiana	14,000,000

12. Operating expenses of oil and gas pipeline companies offshore Louisiana.

a.	Cumulative (1948-1971)	$94,000,000
b.	1971	6,300,000
c.	Portion of cumulative expenses which stayed in Louisiana	75,000,000
d.	Portion of 1971 expenses which stayed in Louisiana	5,000,000

13. Capital expenditures by oil and gas pipeline companies onshore to export gas and crude from Louisiana.

a.	Cumulative (1948-1971)	$400,000,000
b.	Portion of cumulative expenditures which stayed in Louisiana	140,000,000

14. Operating expenses by oil and gas pipeline companies onshore to export gas and crude from Louisiana.

a.	Cumulative (1948-1971)	$86,000,000
b.	1971	5,800,000
c.	Portion of cumulative expenses which stayed in Louisiana	70,000,000
d.	Portion of 1971 expenses which stayed in Louisiana	4,600,000

15. Capital expenditures for natural gas processing plants to process offshore gas.

a.	Cumulative (1948-1971)	$140,000,000
b.	1971	10,000,000
c.	Portion of cumulative expenditures which stayed in La.	50,000,000
d.	Portion of 1971 expenditures which stayed in Louisiana	4,000,000

16. Operating expenses for natural gas processing plants which process offshore gas.

a. Cumulative (1948-1971)	$50,000,000
b. 1971	8,000,000
c. Portion of cumulative expenses which stayed in Louisiana	40,000,000
d. Portion of 1971 expenses which stayed in Louisiana	6,000,000

SERVICE COMPANY PERSONNEL EMPLOYED IN
LOUISIANA OFFSHORE OIL AND GAS INDUSTRY 1/

		Reference
Fabrication Yards for Offshore Platforms	6,000	1
Derrick Barge	1,400	1
Deep Sea Divers	500	1
Boat Transportation	2,800	2
Helicopter and Float Planes	950	3
Oil Barges	170	2
Drilling Rigs	4,000	4
Workover Rigs	1,320	5
Production Equipment Fabricators	2,000	1
Caterers	1,500	6
Drilling Mud	870	7
Directional	120	8
Seismic	600	9
Contract Maintenance	1,000	10
Government Employees	350	11
Pipeline Companies	300	12
Pipeline Contractors	300	13
Supply Company	450	14
Wellhead Suppliers	400	15
Tool Companies	900	16
Service Companies	1,000	17
Miscellaneous	3,070	
Total	30,000	

1/ API Committee on Exploration, Subcommittee on Production 1971.

REFERENCES

1. Data quoted in Acadiana Profile, Vol. 2, No. 5 July/August 1970.
2. Data supplied by Shell Oil Company Transportation based on 950 boat $\pm$ and a crew of 3 per boat and count of oil barge personnel.
3. PHI has about 900 employees (from PHI) plus other smaller companies.
4. Based on 80 active rigs with 50 men/rig average crew.
5. Based on 45 large rigs with 50 men/rig and 28 small rigs with 20 men/rig.
6. Based on Chevron personnel department survey of five of the largest offshore catering companies.
7. IMC and Millwhite report 270 people, assume 300 for Magcobar and Baroid and 300 for smaller companies.
8. Based on one man for 60 of 80 rigs plus one backup.
9. Based on 12 crew years with 50 men/crew.
10. Shell and Chevron report about 400 people in this category, estimated upward.
11. Reported by USGS, State Mineral Board, and Coast Guard.
12. U.S. Census shows 803 employed in Louisiana in this category, estimated downward for offshore component.
13. Based on 100 people for Brown and Root.
14. Bethlehem has about 45 men scaled by factor of 10 for numerous other suppliers.
15. Cameron reported 200 men, doubled for Grey, National, etc.
16. Otis reported 575, scaled upward for others.
17. Halliburton and Schlumberger estimate 680, scaled upward for others.

MISCELLANEOUS DATA

OCS Total Production Value 1953-1972 (U.S. Government)

Oil Condensate	$9,011,860,920
Gas	3,228,114,633
Gasoline and LPG	221,413,785

OCS Total Royalty Value 1953-1972 (U.S. Government)

Oil Condensate	$1,591,139,647
Gas	502,568,780
Gasoline and LPG	16,214,775

Total Royalty, Rental and Bonuses paid to State of Louisiana (1948-1971)

From Offshore Fields	$ 678,000,000

Petrochemical Plants in Louisiana

Number of Plants	56
Employees	20,000
Payroll	$225,000,000/year

Petroleum Refining in Louisiana

Number of Operating Refineries	21
Estimated Crude Capacity	1,660,000 BPD
Employees	10,355
Payroll	$110,900,000/year

In summary, the proposed sale is viewed as not adversely impacting the present socio-economic factors in Louisian. In fact, the sale, by replacing declining output from other sources, will serve to maintain the levels of employment and income in the area as mentioned above.

Any increment or decrement to present output that results from this sale will have a pronounced effect on the areas economy. This is due both to the area's dependence on petroleum and related industries and the operation of the multiplier process.

J. Potential Impact of Royalty Bidding

Section I. indicate that 10 tracts will be offered on a royalty bidding basis, that is leases will be issued to the highest royalty bidder. The same operating orders and regulations (30 CFR 250) would apply to the royalty leases and consequently the provisions for protection of the environment would be the same as for other tracts in this sale. The matrix analysis indicates that seven of the ten tracts are gas prone and three are oil and gas prone. Two (Tract Nos. 193 and 290) have been classified as high environmental risk, three (Tract Nos. 25, 30, and 42) as moderate risk and five (Tract Nos. 80, 103, 145, 208 and 237) as minimum risk. The effects which royalty bidding for the tracts will have on Federal revenue, competition, and the rate of production can only be determined at the proposed lease sale and during subsequent production activities. It is possible, however, that less production would be derived from a royalty bid lease than from a bonus bid lease because production costs would be higher under the royalty system than under the current system.

If a reduction in the royalty rate were not obtainable, it is possible that the royalty leases would at a comparatively early point in time become uneconomic in terms of recovery, leading to early abandonment of the wells. If the leases were thus abandoned before all available oil and gas has been produced, it would be

necessary to compensate in some manner for this loss of expected production. This could be obtained in one of two ways. The Department could choose to offer leases on other lands containing estimated reserves equal to the amount of reserves lost in the abandoned royalty leases. An incremental environmental impact associated with the exploration and development of the additional leases would then take place. On the other hand, the royalty leases could be relinquished to the government and the lands subject to those leases could subsequently be reoffered, but even this would lead to additional environmental impacts arising from a new lessee's exploration and development of the tract.

It is also possible that the acquisition of royalty leases may be made by smaller companies lacking the necessary financial resources to provide the necessary environmental protection and, in particular, to assume the liability for damage arising from the operations. The Regional or National Oil and Hazardous Substances Pollution Contingency Plan provides, however, that the government would move in to clean up the oil in the event that the lessee could not do so, and subsequently bill the lessee for the cost of the cleanup.

The above possibilities could be reduced, however, if the assumption is made that the money which would otherwise be spent on bonuses would be redirected into exploration and development, thus allowing a high royalty rate to be economic and to provide smaller companies with sufficient funds to account for the liability of damage.

Analysis of the environmental impacts of royalty bidding at this time must inevitably be hypothetical, and only by actual experience can the actual environmental impacts be learned.

K. A Matrix Analysis of Some Possible Adverse Impacts on the Environment and Related Uses

In this section, a matrix system is introduced for the purpose of identifying and analyzing on a tract-by-tract basis those factors resulting from the proposed sale which could have an impact on the environment and which lend themselves to such an analysis. The matrix itself is simply a device used for displaying the interrelationships of some of the impact-producing factors (on the horizontal axis of each matrix) with coastal activities and resources which could sustain an impact (on the vertical axis of each matrix), and for assigning values to these interrelationships.

1. Purpose - The purpose is to analyze some of the possible impacts of the proposed OCS lease sale on the environment using a matrix analytical technique in an attempt to provide the decision-maker and reviewer with an array of factors which must be considered in order to form value judgments concerning the importance of these impacts to the environment.

2. Significant Resource Factors - The matrix analysis examines major factors which could sustain negative impacts as a result of the development of the tracts included in the proposed lease sale. Significant resource factors appear on the vertical axis of each matrix and for purposes of this analysis have been identified and placed into two groups as follows:

a. Natural Resource System

Refuges/wildlife management areas 1/

Unique and highly productive areas 2/

Biota seaward of estuary/nursery areas

Beaches

b. Coastal Activities/Multiple Uses

Shipping

Recreation (boating, swimming, water oriented activities other than sport fishing)

Commercial fishing

Sport fishing

3. Impact Producing Factors - The matrix includes two major categories of factors which can impact on significant resources (i.e., natural resource systems, and coastal activities) as a result of the development of proposed OCS oil and gas leases. The Impact-Producing Factors appear on the horizontal axis of each matrix and have been identified as follows:

a. Structures (e.g., platforms, fixed structures and artificial islands)

b. Oil Spills

1/ Includes parks, sanctuaries, historical landmarks, etc.

2/ Includes marsh, estuary, and nursery areas.

Other impact-producing factors such as debris and pipeline construction cannot be analyzed on a tract-by-tract basis, and therefore are not included in this matrix section. However, these and other factors were discussed on the basis of the entire sale earlier in the statement.

4. Analytic Procedures - Each impact-producing factor is assumed, i.e., structures are assumed to be erected on tracts, and a 1000 bbl. spill is assumed, and each is analyzed on the basis of (A) its potential magnitude and persistence which we have termed its importance, and (B) its proximity to high value resources or coastal activities/multiple-uses. A series of scales have been devised for the purpose of assigning a range of values consisting of importance and proximity to each impact-producing factor. These scales together with definitions and discussions are presented below.

(A) IMPORTANCE

a. Structures:

Under some conditions, offshore structures have an adverse effect on commercial fishing activities. Depending on currents and underwater obstacles an offshore structure can remove areas of trawling and purse seining waters. Heavy concentrations of platforms can make trawling and purse seining difficult.

Oil and gas platforms pose a hazard to commercial fishing and boating in general. Directional drilling from outside shipping lanes, however, can be used to develop tracts lying partially in shipping lanes.

An estimate of the importance of the impact of structures on the environment consists of two factors: 1) quantity--in this case it is estimated that all tracts 5,000 acres or more in size will average two structures per tract, even though some tracts may never be developed, and 2) time--all structures will remain on site for an average period of 15 to 20 years. Structures also have positive impacts; they may serve as aids to navigation and rescue stations, and they attract fish, which in turn attracts sports divers and sport fishermen.

b. Oil Spills:

The same two factors for estimating the importance of oil spills on the environment are as follows: 1) quantity--our analysis is based on all spills of 1,000 bbl. or more, and 2) time--based on past experience the oil itself may remain in contact with, or a hazard to, the environment for a period of 1 to 90 days.

A scale indicating the importance structures and oil spills pose to significant resources or coastal activities/multiple-uses follows:

SCALE OF IMPORTANCE

100 - Oil Spills: complete destruction of a resource within the immediate area of a spill, impossible to remedy or control; Structures: permanent obstruction and disruption of coastal activities/multiple uses.

80 - Oil Spills: very hazardous to life and extremely difficult to remedy; Structures: very inconvenient interference with coastal activities/multiple uses.

60 - Oil Spills: hazardous to plant and animal life and costly to remedy or control; Structures: inconvenient interference with coastal activities/multiple uses.

40 - Oil Spills: unsightly and potentially hazardous to plant and animal life but relatively easy to remedy or control; Structures: some minor inconvenience to coastal activities/multiple uses.

20 - Oil spills: unsightly; Structures: slight inconvenience.

0 - No adverse effect.

(B) PROXIMITY

Each tract is assigned a proximity number, based on its distance from shore or high-value resources.

A vector analysis consisting of nearshore current direction and velocity, and wind direction and velocity data in the study area would be necessary to construct an oil spill simulation model. Unfortunately, reliable and extensive nearshore surface current data are not available for the study area. However, observations for oil slicks indicate an average drift rate at approximately 3% of the surface wind speed in the direction of the wind. 1/ Therefore, this simple formulation will be applied to the extensive wind data available for the Gulf coast of Louisiana (see Attachment D) for monthly wind patterns based on records dating back as far as 1881 for the purpose of estimating the shoreward rate of drift of an oil slick. 2/ This in turn will serve as a basis for assigning proximity values to each tract in terms of its relation to shore or high value, vulnerable resources. It should be emphasized that the estimated direction and rate of oil slick movement is an approximation of the driving force exerted upon an oil slick by the wind. It does not consider slick geometries, natural dispersive forces,

---

1/ The 3% figure is an order-of-magnitude figure which, in our estimation is more representative of the open ocean that are some of the values reported in the literature pertaining to confined bays or semi-enclosed waters.

2/ A shoreward rate of drift is the single most important factor involved in estimating time and possible impact points of an oil spill on nearshore or onshore high value, vulnerable resources.

evaporation, absorption, dissolution or emulsification rates, and other forces that could cause cessation of the spreading movement of a slick.

The wind rose data in Attachment D indicates that the critical months for a possible shoreward slick movement in the New Orleans and Galveston areas would be March, April, May, June and July. An oil slick in the New Orleans area during these months would move at an estimated rate of 0.3-0.36 knots in the direction of the shore (i.e., north by northwest) at a 30-35% frequency. An oil slick in the Galveston area during these same months would move at an estimated rate of 0.30-0.34 knots in the direction of the shore (i.e., north by northwest) at a 35-40% frequency. The probability of an oil slick reaching shore is lower during the months of September, October, November, December and Janaury than it is during the spring and summer months.

For purposes of analyses we have established a proximity scale which is based on the following assumptions:

a) An oil spill of 1000 bbl. or more has occurred.

b) The rate of shoreward drift of an oil spill in the study area under normal conditions is estimated at 0.3-0.5 knots. For purposes of this analysis the 0.5 knot rate is used.

c) The shoreward movement of an oil slick will occur more frequently in the spring and summer than in the fall and winter, but no distinction concerning the season

will be included in the proximity scale. All tracts are considered to be in areas that could produce a shoreward drift of an oil slick at any given time should a spill occur. Although this would be least likely to occur with regard to tracts immediately seaward of the delta.

d) A 12-hour response time is necessary to implement contingency measures to stop or retard oil from reaching shore, or high value, vulnerable resource area. The oil industry presently has a contingency plan for containing and cleaning-up oil spilled in Federal areas of the OCS offshore Louisiana and Texas which meets this response time capability.

Based on these assumptions each tract is assigned a proximity number based on the following scale:

PROXIMITY SCALE (Oil Spills)

1.0 -	Tract	is	within	7.0	statute	miles	of	shore	or	significant	resource. 1/
0.9	"	"	"	7.1-8.0	"	"	"	"	"	"	"
0.8	"	"	"	8.1-9.0	"	"	"	"	"	"	"
0.7	"	"	"	9.1-11.0	"	"	"	"	"	"	"
0.6	"	"	"	11.1-13.0	"	"	"	"	"	"	"
0.5	"	"	"	13.1-16.0	"	"	"	"	"	"	"
0.4	"	"	"	16.1-19.0	"	"	"	"	"	"	"
0.3	"	"	"	19.1-23.0	"	"	"	"	"	"	"
0.2	"	"	"	23.1-27.0	"	"	"	"	"	"	"
0.1	"	"	"	27.1-32.0	"	"	"	"	"	"	"
0.0	"	"	"	32.1-up	"	"	"	"	"	"	"

The proximity scale with regard to structures takes into account their potential impact on shipping and their location in relation to unexplored munitions dumping area. This scale is different than that for oil spills, as shown below.

1/ A line 12 miles seaward of the shoreline or outer islands, where appropriate, represents the point from which proximity of tracts to intensive commercial and sport fishing activities are measured, i.e., tracts within 19 miles of the shoreline are assigned a value of 1.0, those from 19.1-20.0 are assigned 0.9, and so on.

Proximity Scale (Structures)*

1.0 - Tract partially within shipping lane, anchorage area, natural resource system, activity or dumping area. 1/

0.8 - Tract within one mile of shipping lane, anchorage area, natural resource system, activity or dumping area.

0.6 - Tract within 1.1-3 miles of shipping lane, anchorage area, natural resource system, activity or dumping area. 2/

0.4 - Tract within 3.1-6 miles of shipping lane, anchorage area, natural resource system, activity or dumping area. 3/

0.2 - Tract within 6.1-10 miles of shipping lane, anchorage area, natural resource system, activity or dumping area.

0.0 - Tract beyond 10 miles of shipping lane, anchorage area, natural resource system, activity or dumping area.

* Distances for commercial shipping were taken from the edge of a tract to the nearest edge of a shipping lane or anchorage area; all other distances were measured from the center of the tract.

1/ Tracts located in water depths shallower than 27m are assigned a value of 1.0 due to their location in areas of intensive commercial fishing.

2/ Tracts ranging in depth from over 27m to 64m are considered to be in an intensive commercial fishery area for only one species, such as brown shrimp. These tracts have been assigned a value of 0.6 to reflect the fact that offshore structures in these water depths will be in proximity to an intensive single species fishery. Tracts identified by the National Marine Fisheries Service which contain high densities of royal red shrimp of commercial potential have also been given an upgraded value of 0.6.

3/ Each proposed tract located in water depths greater than 64 m has been assigned a value of 0.4. This value has been assigned to reflect the fact that commercial fishing activities occur throughout the Gulf and therefore, all platforms placed on the continental shelf will be in proximity to some kind of commercial fishing activity regardless of water depth or distance from shore.

(C) RELATIVE ENVIRONMENTAL IMPACT FACTOR

A relative environmental impact factor is a product of Importance, and Proximity, and is expressed both for structures, F (St) and oil spills, F (O.S.). The equation for obtaining this factor can be expressed simply as I x P = F (St. or O.S.).

The higher the relative environmental impact factor, the higher the potential for environmental damage. Tracts with overall high environmental indices will be singled out for additional consideration in accordance with the scale below. It is very important for the decision-maker or reviewer to keep in mind the possible synergistic and/or cumulative effects resulting from a tract having one or more categories within a high index range.

This scale of relative environmental impact factors is proposed for determining the potential damage a tract might pose to a significant resource or activity.

Relative Environmental Impact Scale

Greater than or equal to 50	Relative environmental impact factor in this range indicates that the tract should be carefully scrutinized. Depending upon the significance and character of the resource that may be affected, possibilities in the decision include: (1) Withdraw the entire tract from the proposed offering. (2) Offer only a portion of the tract. (3) Offer the tract with special stipulations included in the lease to reduce the potential for damage or hazard. (4) Offer the tract because of mitigating circumstances with or without special stipulations.
Greater than zero but less than 50	Relative environmental impact factor in this range indicate that the tract could be developed safely within existing standard practices and operating regulations without significant damage to the resource involved. Additional special stipulations in the lease would not normally be necessary.

The individual, tract-by-tract, matrices have been appended to this statement. See Attachment H. The following section presents a recapitulation of the matrices and the section following that presents a summary risk analysis.

L. Recapitulation of the Matrices

1. Refuges/Management Areas

There is a total of 18 tracts (Tract Nos. 125, 126, 129, 130, 187, 188, 192-198, 200, 201, 204, 205, and 292) in this proposed sale that reflect an environmental impact factor for oil spill of 50 in relation to refuges/management areas. This reflects the fact that these tracts are each within 16 miles of one of the several wildlife refuges and management areas found along the Louisiana coastline and a massive oil spill from any of these tracts could affect these areas.

2. Unique and Highly Productive Areas

(Marsh, Estuary, Nursery)

There are 34 tracts (Tract Nos. 123-126, 129-131, 162-165, 168-170, 180, 182-184, 186-190, 192-198, 200, 204, 205, and 292) in this sale which reflect an environmental impact factor of over 50 for oil spills in relation to unique and highly productive areas. These areas could be severely affected by massive oil spills or leaks of long duration. Several are offshore banks or rises which may possibly serve as snapper/grouper habitats.

3. Biota Seaward of Estuary/Nursery Areas

All tracts in this proposed sale reflect an environmental impact factor of 40 for oil spills in relation to this natural

resource category. Of all the categories included in the matrix analysis, the adverse impact of an oil spill on biota in the open water of the sea, is the one about which the least is known. Although data in this area are sparse, some of the effects are discussed in section IV of this statement.

4. Beaches

There is one tract (Tract No. 195) in this proposed sale which has an environmental impact factor of over 50 for oil spills in relation to beaches.

5. Shipping

There is a total of 47 tracts (Tract Nos. 31, 33, 34, 40, 41, 43-45, 48-49, 53, 56-58, 83, 186, 188, 193-195, 197, 198, 200, 204, 205, 216-219, 225-233, 244, 245, 258, 259, 261, 273, 274) in this proposed sale which have an environmental impact factor of 80 for structures in relation to shipping. This is a reflection of the fact that each of these tracts are partially within shipping safety lanes. Development of these 47 tracts will be subject to Federal regulations as described in section V.B. of this statement.

There are an additional 18 tracts (Nos. 30, 32, 39, 42, 55, 185, 189-191, 196, 212, 234-236, 242, 243, 260 and 279) which have an environmental impact factor of 64 for structures in relation to

shipping. This is a reflection of the fact that each of these tracts are within one mile of established safety fairways. No other tracts in this proposed sale are within one mile of shipping safety fairways.

6. Outdoor Recreation

There is one tract (No. 195) in this proposed sale which reflects an environmental impact factor of 50 or more under either structures or oil spills for this category.

7. Commercial Fishing

There is a total of 15 tracts (Tract Nos. 125, 126, 129-131, 165, 168-170, 180, 195-197, 200, 201) which have an environmental impact factor of 80 for both oil spills and structures in relation to commercial fishing. In addition, there are 88 tracts (Tract Nos. 1-42, 65-73, 84-96, 127, 128, 132-135, 157-161, 166, 167, 176, 199, 214, 217, 226-228, 235, 241, 242, 250) which have an environmental impact factor of 80 for structures in relation to commercial fishing and 23 tracts (Tract Nos. 181-194, 198, 202, 204, 205, 212, 286, 289, 292, 293) which have a factor of 80 for oil spills in relation to commercial fishing. Therefore, there are a total of 115 tracts in this proposed sale which have an environmental impact factor of 80 for either oil spills, structures or both in relation to commercial fishing. Accordingly, these tracts should be carefully scrutinized as part of the decision-making process.

In addition, tract Nos. 290, 295 have an environmental impact factor of 72 for oil spills in relation to commercial fishing; tract No. 287 have a impact factor of 64 and tract No. 294 have an impact factor of 56. All other tracts have factors less than 50 for the impact of structures and oil spills on commercial fishing.

A suggested stipulation concerning the development of all the tracts in this proposed sale has been presented in section V.B. If adopted, this stipulation would help mitigate the impact resulting from the placement of structures in relation to commercial fishing activities. However, the potential adverse impact on commercial fishing activities and commercial fish species resulting from oil spills cannot be mitigated by a special stipulation.

8. Sport Fishing

There are a total of 38 tracts (Tract Nos. 125, 126, 219-131, 165, 168-170, 180-198, 200-202, 204, 205, 212, 286, 289, 292, 293) which have an environmental impact factor of 80 for oil spills in relation to sport fishing activities. Tract No. 123 has an impact factor of 72 for oil spills. This is a result of the proximity of these tracts to sport fishing areas.

In every case, the environmental impact factor of structures for sport fishing is fixed at a zero. This reflects the fact that

offshore structures have a favorable impact on sport fishing activities by concentrating fish around the platforms and thereby increasing the average catch. Eighty percent of the sport fishing from platforms is undertaken within 12 miles from shore, although some sport fishing craft make overnight trips and can venture out much further. A proximity value of 1.0 was assigned to each tract if it was located within 12 miles of the shoreline; 0.2 was assigned if it was located between 13 and 20 miles of shore, and 0.0 beyond 20 miles. Offshore platforms also serve as aids to navigation, a source of assistance in emergenices and havens for small boats in storms. Platforms resulting from blocks leases as a result of this proposed sale could be expected to have a positive and favorable impact on sport fishing and small boat recreationists over a period of time (up to 20-25 years).

9. Ordnance Disposal Areas

There are no ordnance disposal areas on the Louisiana OCS.

M. Summary Risk Analysis

Three risk categories will be used to rank the degree of potential hazard the tracts in this proposed sale pose to the environment. These categories are discussed below:

1. High Hazard Potential to the Environment

Highly hazardous may be generally defined as a tract which is oil, or oil and gas, prone and which is in such close proximity to a high value-critically vulnerable resource as to disallow the minimum present practical response time 1/ necessary to effectuate oil spill containment, clean-up and contingency measures to stop or retard the spill from impacting upon the resource. Also, a tract may be considered high hazardous if it is oil prone and is wholly located in an unstable sediment zone, or it shows potential impact on a number of other resources or resource uses as determined in the matrix analysis. In all, for this proposed sale there are 39 tracts which fall into the high risk potential category. Fifteen tracts appear to be located in an unstable sediment zone around the Mississippi River delta. High resolution geophysical information concerning the nature of the bottom conditions for tract Nos. 182-184, 186-194, 198, 204, and 205 must be obtained before these lease areas can be adequately evaluated. This information is supplied by the lessee with the exploration and

---

1/ Minimum practical response time would be at least 12 to 18 hours from the time a spill occurred to the time appropriate equipment can be at the spill site.

development plans required for each operation. For purposes of this summary risk analysis and given that the general data concerning bottom conditions in the area of the subject 15 tracts are available at this time, tract Nos. 182-184, 186-194, 198, 204-205 are considered to pose a high hazard potential to the environment. In addition, however, these tracts are oil prone and are in close proximity to refuge and management areas and unique and highly productive areas of the delta, thus lending themselves to a high risk classification.

Tracts numbered 129-131, 168, 180, 185, 195-197, 200-202, and 212 are also considered to have high environmental risk due to the fact that they are oil prone and are close to the shore which in this location consists of marsh and estuarine areas and wildlife refuge and management areas.

Tracts numbered 286-295 are also considered to have high environmental risk for the following reasons: they are oil prone; they are relatively close to shore, which in this location consists of marshes, estuaries, refuges and management areas; and they are located in deep water, in some cases deeper than current operating depths in the Gulf of Mexico.

Tract 165 is considered high hazard in this particular statement because it is oil and gas prone, impacts upon commercial fisheries and has been specified as a snapper and frouper bank and possible coral reef by the National Marine Fisheries Service.

By including a tract in the high hazard potential category it is intended to point out that a particular tract should receive special consideration and analysis before it is offered, or special stipulations should be placed on it prior to development to insure safe development.

2. Moderate Hazard Potential to the Environment

Moderately hazardous may be defined as an oil or oil and gas prone tract whose proximity to a high value-critically vulnerable resource does not preclude adequate response time (based on current industry capability in the Gulf of Mexico, offshore Louisiana and Texas) necessary to effectuate containment, clean-up and contingency measures to stop or retard the spill from impacting upon the unique resource area. Gas prone tracts which impact on commercial fishing or shipping are also placed in this category mainly due to their proximity to shipping lanes and/or areas in which commercial fishing is important. Under this category are gas prone tracts which serve as snapper-grouper banks.

Most oil prone tracts, if not determined to be highly hazardous to the environment, are placed in this category for primarily two reasons: (a) either they are capable of spilling oil (the effects of an oil spill on open ocean marine biota is also considered adverse although not as severe as the effects on unique, usually nearshore or onshore, high value resources); or (b) no clean-up and containment equipment can be effectuated during adverse weather conditions, such

as violent storms and hurricanes (this type of equipment available today is not very effective in five-foot or more seas).

In summary, in this proposed offering there are 139 tracts considered to be moderately hazardous to the environment. These tracts are as follows:

West Cameron - (Tract Nos. 1-29)

West Cameron - West Addition (Tract Nos. 30-42)

East Cameron - (Tract Nos. 65-73)

Vermilion - (Tract Nos. 84-96)

South Marsh Island - South Addition (Tract Nos. 116-118)

South Marsh Island - North Addition (Tract Nos. 125-128)

Eugene Island - (Tract Nos. 132-135, 138)

Eugene Island - South Addition (Tract Nos. 140, 141)

Ship Shoal - (Tract Nos. 157-161)

Ship Shoal - South Addition (Tract Nos. 162, 163)

South Pelto - (Tract Nos. 166, 167)

South Timbalier - (Tract Nos. 169-175)

South Timbalier - South Addition (Tract No. 176)

Grand Isle - (Tract No. 177)

Grand Isle - South Addition (Tract Nos. 178, 179)

West Delta - (Tract No. 181)

Main Pass - (Tract No. 203)

Main Pass - South and East Addition (Tract Nos. 210, 211)

Garden Banks - (Tract Nos. 214, 217, 226, 227, 228, 235, 241, 242)

New Orleans - South No. 1 NG-15-3 Area (Tract Nos. 250, 251)

Mobile South No. 2 - (Tract Nos. 258-285)

3. Minimal Hazard Potential to the Environment

Minimally hazardous may be defined as a gas prone tract whose development under existing operating orders, regulations and safety requirements promises a low level of disruption and adverse effects to the environment. Experience indicates that the impacts resulting from development of tracts of this type are not so much ecological in nature as they are conflictural with other uses or activities in a marine area. In most cases, such conflicts or hazards can be mitigated by enforcement of existing regulations or by attaching special conditions or stipulations to the lease concerning its development.

In this proposed sale, 97 tracts in the following lease areas are considered to be minimally hazardous to the environment:

West Cameron - West Addition (Tract Nos. 43-46)

West Cameron - South Addition (Tract Nos. 47-64)

East Cameron - (Tract Nos. 74, 75)

East Cameron - South Addition (Tract Nos. 76-83)

Vermilion - (Tract No. 97)

Vermilion - South Addition (Tract Nos. 98-108)

South Marsh Island - South Addition (Tract Nos. 109-115)

Eugene Island - (Tract Nos. 136, 137)

Eugene Island - South Addition (Tract Nos. 139, 142, 143)

Main Pass - (Tract No. 199)

Main Pass - South and East Addition (Tract Nos. 206-209)

Garden Banks (Zone 15) - (Tract Nos. 213, 215-216, 218-225, 229-234, 236-240, 243-245)

New Orleans (Zone 15) - (Tract Nos. 246-249, 252-257)

This conclusion is based on the following considerations: a) all are gas prone tracts, b) all are deeper than 27m, and thus have less impact on commercial fishing; and c) all are farther than one mile from the nearest shipping lanes.

Additionally, the 20 oil and gas prone tracts numbered 119-124, 144-156, and 164 are considered minimally hazardous to the environment for the following similar considerations: a) all are farther than 66 miles from the coast; b) all are located in water depths greater than 64m; and c) all are farther than one mile from the nearest shipping lanes.

None of the 127 tracts denoted as minimally hazardous to the environment are located in unstable sediment zones, and any unforeseen conflicts with other uses and activities of the areas will be mitigated by regulations, operating orders, and where necessary, special stipulations.

For specific tract-by-tract characteristics see the appended matrix tables and the preceding section titled "Recapitulation of the Matrices".

V. MITIGATING MEASURES INCLUDED IN THE PROPOSED ACTION

The Department has developed the following strategy for safe development of the mineral resources of the OCS.

Management of the mineral resources of the OCS will be conducted in such a manner as to cause these resources to make a significant contribution toward supporting the present and future national economy at a rate consistent with maximum possible protection of the environment, orderly and timely development of the resource, and receipt of a fair market value return to the Federal Government.

Reasonably safe development of oil and gas resources on the OCS can be achieved through strict enforcement of lease stipulations and obligations, (detailed in the OCS operating regulations and orders) 1/ and must be based on sound operating practices backed by effective contingency actions in the event that pollution occurs as a result of a natural disaster, human error, or equipment failure.

Research and development programs in exploration, production, transportation, containment and clean-up technology, all of which provide greater safeguards for the environment, are being conducted by the Department of the Interior, other Federal agencies and

---

1/ OCS operating orders for the Gulf of Mexico have been appended to this statement. See Attachment A.

private industry. The Coast Guard in fiscal year 1972 spent in excess of $3,000,000 for research and development on oil containment booms, oil recovery devices and techniques for forecasting movement of oil slicks. The oil industry during the period 1966-72 has reportedly committed nearly $235,000,000 for environmental research and development on air and water pollution. Currently the American Petroleum Institute (API) and the USGS have a cooperative effort underway which will document research work on safety and anti-pollution equipment, recommend additional research, and supervise the management of additional safety or anti-pollution research projects funded by API. As advances are made, OCS operating regulations and orders will be revised and the new technology applied to existing leases as well as new leases. Revisions of the regulations and formulations of lease stipulations may also result from the review of environmental impact statements by the agencies and the interested public.

The following discussion concerns the mitigatory measures which will influence possible adverse impacts that could result from this proposed sale. These measures are presented as they relate to oil spills, offshore structures and pipelines as well as other impact-producing activities associated with OCS oil and gas development.

A. Oil Spills

1. Regulations

Regulations governing OCS oil and gas lease operations in the Gulf of Mexico are contained in Title 30, Code of Federal Regulations and OCS Orders Nos. 1-4, 6, 7, dated August 28, 1969, No. 5, dated June 5, 1972, Nos. 8-9, dated October 20, 1970, No. 11, dated April 5, 1972, and No. 12, dated August 13, 1971. (See Attachment A). Leasing regulations are contained in Title 43, Code of Federal Regulations. The regulations established procedures and requirements to be followed in all stages of lease operations: exploration and development, drilling, production, transportation (pipeline construction and operation) and abandonment.

A general description of operating requirements under the existing regulations follows:

a. Plans: Operating plans must be submitted by the operators and approved by the Geological Survey (GS) before each stage of operations is initiated (exploration, development, abandonment). Approval of all operations must be obtained prior to their commencement.

b. Operator Inspection and Testing: The operator is required to inspect all aspects of the safety systems at specific intervals, e.g., daily pollution inspection on manned facilities, "frequent" inspection on unmanned facilities, monthly test of check valves. Detailed records of inspections and tests are required. 1/

1/ See Vol. 2, Attachment I for drilling and production inspection report forms and the code book which provides interpretation.

c. Reports: The operator is required to report all spills or leakage of oil to GS without delay. He is also required to notify GS of any unusual condition, problem or malfunction within 24 hours. 1/

d. Safety Devices: Required safety devices include subsurface safety devices, high-low pressure shut-in controls, high liquid level shut-in controls, pressure relief valves, automatic fail-close valves at the well head, automatic fire fighting systems, automatic gas detector and alarm systems, and other safety devices on production equipment; high-low pressure sensing devices and automatic shut-in valves on pipelines; and blowout preventers, related well control equipment, and mud system monitoring equipment on drilling wells.

e. Waste Disposal: The lessee is prohibited from disposing into the ocean any oil (except that oil in produced formation water must average no more than 50 ppm) 2/, untreated waste material or other materials which may be harmful to aquatic life or wildlife. Any drilling mud which may contain toxic substance must

---

1/ 30 CFR 250.45.

2/ OCS Order No. 8 (2.A.(5), Gulf of Mexico, Attachment A.

be neutralized before it can be dispersed in the ocean. Drill cuttings which are predominantly sand and shale, must be processed, and oil removed, before they can be disposed of in the ocean. 1/ Sewage samples shall be collected semi-annually by lessee personnel and the samples submitted to a laboratory for analysis. Results of the analysis will be available on the platforms and rigs for inspection by the USGS technicians. GS personnel are responsible for enforcing the requirement but do not take the samples.

f. Site Clearance: When an installation is no longer needed for development of the lease, the well is plugged with cement and all casings and piling must be severed and removed to at least 15 feet below the ocean floor and the location must be dragged to clear the site of any obstruction.

g. Debris: Regulations and OCS Orders prohibit the disposal of debris into the Gulf of Mexico. Solid waste must be either incinerated or transported to shore for disposal in accordance with applicable requirements under State and Federal law.

h. Contingency Plans and Equipment: The operator is required to have an approved plan for controlling and removing pollution which provides for:

1/ Waste disposals must comply with the 1972 Amendments of the Federal Water Pollution Control Act. Permits for disposals must be obtained from EPA under the National Pollutant Discharge Elimination System. See Sec. V.D.7. of this volume.

(1) Standby pollution control equipment, including containment booms, skimming apparatus, and approved chemical dispersants immediately available to the operator at a land based location.

(2) Regular inspection and maintenance of such equipment.

The Oil and Hazardous Substances Pollution Contingency Plan, Gulf Coast Region, is operative and has recently been revised and updated to agree with the National Plan 1/. In addition, the Coast Guard has established the Gulf Coast Team of the National Strike Force (NSF) at the NASA Mississippi Test Facility, Bay St. Louis, Mississippi for the purpose of responding to oil spills in the Gulf of Mexico. The National Strike Force has been established in accordance with the Federal Water Pollution Control Act and the National Oil and Hazardous Substances Contingency Plan.

The Gulf Coast Team is fully operative at this time and presently consists of 14 men with plans to increase to a total of 19 men in the near future. This team is capable of responding to incidents within 2 hours of notification by the appropriate District Commander.

2. Inspection

Evidence of compliance with the regulations and lease requirements is obtained through surveillance of the operations under the lease and enforcement of specific requirements. The inspection system

---

1/ See also V.A.4.b. of this volume and discussion of the National Oil and Hazardous Substances Pollution Contingency Plan.

of the Geological Survey includes: (1) review and approval of plans before each operating stage is initiated, (2) close review and follow-up as necessary, by GS inspectors, of all reports required of the operator by the regulations and orders, (3) on-site inspection and (4) aerial monitoring through the use of helicopters (operators are also required to inform each other of oil spills or other irregularities which they observe).

a. Operator reports: A comprehensive reporting system covering all oil spills and any unusual conditions (for example: reporting and investigation of a persistent oil slick from an unknown source such as a sunken ship or natural oil seep) is required by the orders and is a key factor in monitoring operations. Operators are also required to maintain records for GS inspection of required periodic tests of safety equipment. Compliance with reporting requirements can be assured only by periodic on-the-site inspection and aerial monitoring.

b. On-Site Inspection: During the course of drilling, all operations are inspected at least one time. Leases in certain areas or in a particular development stage may require more inspections to assure the achievement of safety objectives. GS is continuing the systematic inspection program and a more stringent enforcement policy. This has resulted in increased

operator compliance along with greater coverage of production operations and better documentation of inspection results.

A complete drilling inspection is normally conducted on each drilling rig approximately every six weeks. Random inspections may be made more frequently. Depending on the number of drilling rigs in each District, the frequency of inspections on a rig may vary from six to twelve per year. All producing platforms are inspected at least once a year and random inspections are made more frequently on some. The frequency rate for platform inspections is approximately once every nine months.

The total number of warnings issued and suspensions ordered for infractions of OCS Orders which occurred during normal daily inspections from December 1, 1972 through April 30, 1974, are as follows:

WARNINGS			SUSPENSIONS		
Drilling	Workover	Production	Drilling	Workover	Production
46	3	2,649	26	4	1,437

Approximately 173 on-site inspections of pollution incidents were made from December 1, 1972 through April 30, 1974, in response to reports submitted by operators.

Listed below are the results of on-site inspections performed in response to the observations made during pollution surveillance flights conducted from December 1, 1972 through April 30, 1974:

Pollution Inspections	No. Platforms	No. Wells	Warnings	Suspensions
59	151	999	33	33

A program of intensive inspections is used on OCS leases. Periodically, all available inspectors devote a week to a special inspection, whereupon production platforms and drilling wells are inspected on a random basis; inspections during other periods are conducted on a regular basis with emphasis on operations believed to require special attention. The GS inspector force in the Gulf of Mexico has increased from 7 technicians and 5 engineers as of July 1, 1969 to 33 technicians and 16 engineers as of April 30, 1974. During the period November 1, 1972 through April 30, 1974, technicians spent 4,974 inspection days or 43,316 man-hours, and engineers 547 inspection days or 4,413 man-hours in the field. Detailed inspections were conducted on 1,525 major producing platforms and 1,156 minor platforms (out of a total of 2000) in the Gulf of Mexico from December 1, 1972 through April 30, 1974. Also, during this time period, 886 inspections of single-wells or satellites were made by boat. Approximately 60% of these inspections were unannounced. Included in these inspections were 17,188 well completions. Also, during this time period, 1,571 inspections of drilling rigs were conducted. As of April 30, 1974 in a total of 6,265 holes, there were 9,702 completions capable of producing oil and gas on the OCS lands offshore

Louisiana and Texas. 1/ Approximately 60 drilling rigs were operating in Gulf of Mexico OCS waters as of June, 1974.

c. Aerial Monitoring: "Fly-overs" of the OCS operating areas are programmed on a seven day per week basis by GS inspectors. Any indications of oil pollution or other non-compliance will be followed immediately by an on-site inspection.

During the period January 1 through April 30, 1974, 1,889 pollution surveillance flights were made. The helicopters chartered by the Geological Survey for use of the inspecting personnel flew a total of 7,549 hours.

3. Enforcement

The enforcement policy is intended to: (1) reduce the frequency of non-compliance with lease requirements which may lead to loss of life, loss of property, or damage to the environment; and (2) maintain uniform enforcement standards to be applied to all operations affecting OCS lands in the Gulf of Mexico. When, in the course of an inspection, a requirement pertaining to the prevention of oil pollution or any other safety hazard is found to be in non-compliance, the operation will be shut-in until it is brought into compliance. After a

---

1/ This figure does not include service completions.

shut-in, the operation can only be resumed by authorization of the GS; in all cases, this requires reinspection or a waiver of the inspection requirement. Minor incidents of non-compliance may require only a warning that corrections be made within a week. The operations will be shut-in if the required corrections are not made.

Additional penalties for non-compliance are specific in P.L. 83-212, Outer Continental Shelf Lands Act, Sec. 5(a)(2). "Any person who knowingly and willfully violates any rule or regulation prescribed by the Secretary for the prevention of waste, the conservation of the natural resources, or the protection of correlative rights shall be deemed guilty of a misdemeanor and punishable by a fine of not more than $2,000 or by imprisonment, and each day of violation shall be deemed to be a separate offense." Also Sec. 5(b)(1) and (2) provide for cancellation of non-producing and producing leases by notice subject to judicial review or appropriate judicial proceedings.

The following tables (Tables 6, 7, 8) indicate equipment malfunctions detected during inspections and enforcement actions over three separate periods. Minor incidents of non-compliance result in formal warnings while incidents of non-compliance of a potentially more hazardous nature result in well or platform shut-ins until the operation is in full compliance with regulations and orders.

These tables indicate specific items found to be in non-compliace during special inspections. Basic pollution control items of production equipment in which malfunctions were detected for the time periods identified are as follows:

Table 6 EQUIPMENT MALFUNCTION DETECTED DURING JANUARY THROUGH NOVEMBER, 1971 SPECIAL INSPECTIONS

	No. Checked	Operable	Inoperable or not within acceptable tolerances	Percent Failure
Surface Safety valves	2392	2306	86	3.6%
Flowline sensors	4166	4081	85	2.0%
Check Valves	2222	2052	170	7.7%
Pressure vessels				
High pressure sensors	908	875	33	3.6%
Low pressure sensors	765	744	21	2.8%
Low level shut-in	511	481	30	5.9%
High level shut-in	460	439	21	4.6%
Total	11,424	10,978	446	3.9%

Table 7 EQUIPMENT MALFUNCTION DETECTED DURING JANUARY THROUGH NOVEMBER 1972 SPECIAL INSPECTION

	No. Checked	Operable	Inoperable or not within acceptable tolerances	Percent Failure
Surface Safety valves	1,533	1,480	53	3.5%
Flowline sensors	3,021	2,982	39	1.3%
Check Valves	1,434	1,370	64	4.5%
Pressure Vessels				
High pressure sensors	961	942	19	2.0%
Low pressure sensors	610	600	10	1.6%
High level shut-in	351	345	6	1.7%
Low level shut-in	323	314	9	2.8%
Total	8,233	8,033		2.4%

Table 8. EQUIPMENT MALFUNCTIONS DETECTED JANUARY THROUGH NOVEMBER, 1973 SPECIAL INSPECTIONS

	No. Checked	Operable	Inoperable or not within acceptable tolerances	Percent Failure
Surface safety valves	1,492	1,423	69	4.6%
Flowline sensors	1,327	1,290	37	2.8%
Check valves	1,469	1,385	84	5.7%
Pressure Vessels				
High pressure sensors	1,100	1,077	23	2.1%
Low pressure sensors	784	771	13	1.7%
High level shut-in	405	398	7	1.7%
Low level shut-in	383	375	8	2.1%
Total	6,960	6,719	241	3.5%

Subsurface operated subsurface safety valves are periodically pulled from the wells and checked. This requires removing the valve from the well to inspect and repair or adjust as necessary and reinstall. One company utilized test stands to test the valves performance characteristics under simulated flow and pressure conditions. Surface operated subsurface safety valves are tested in place by releasing hydraulic pressure within the closed system to close the valve and repressuring to open. An average reporting period from May 1973 through July 1973 resulted in approximately 3,000 subsurface safety valves being checked. Of this amount there were 394 failed components detected in the valves but a number of the valves had more than one failed component.

Companies fined in District Court for failure to install subsurface safety devices in offshore oil wells during 1970 in the Gulf of Mexico are presented below (Table 9). Each company entered a plea of <u>nolo contendere</u>. The maximum fine for violation of the Outer Continental Shelf Lands Act is $2,000 per count.

Table 9. MAXIMUM FINES

Chevron Oil Company	$1,000,000
Gulf Oil Company	250,000
Tenneco	32,000
Kerr-McGee	20,000
Mobil	150,000
Continental	242,000
Humble	300,000
Shell	340,000
Union of California	24,000
	$2,358,000

No data for direct comparison of pollution incidences for similar time periods before and after the current "more stringent enforcement policy" are available. However, experienced personnel, private and government, are aware that after public attention was focused on the oil spill at Santa Barbara in January 1969, there has been a great deal less oil pollution in the Gulf from normal oil and gas producing operations. The public awareness, concern, and demand to prevent pollution have been a major factor in the reduction of oil spills.

In the past, major events were catalogued, but less serious events where often not reported. Occasionally, some years ago, wells were even intentionally flowed into the water for short periods during clean-up operations. Now, sophisticated burning devices are designed to consume this well clean-up oil without air or water pollution. More automatic equipment is now in use to shut-in production whenever a leak occurs in pipeline or production facilities. These include but are not limited to pressure sensors and high and low level controls. Drip pans are placed under valves, vessels, and the production system to prevent leaking oil from escaping into the waters of the Gulf.

New reporting and investigative procedures established in the last two years have increased many fold the number of pollution incidents reported as well as the time spent by GS personnel in surveillance flights by helicopters in assuring proper documentation of pollution events.

There have been several detailed studies recently completed concerning operating practices on the OCS. The Department's response to these studies and the steps being taken at this time will improve many facets of OCS management practices. For a discussion of these studies see Vol. 1, Sec. 1.G.

4. Contingency Action

Oil spills will occasionally occur as a result of natural disasters, equipment failure or human error. In the event that such an emergency occurs, the following action will be taken:

a. Requirements of OCS Order No. 7 1/

In the case of any spill, the operator is required to initiate action to control and remove the oil pollution in accordance with his approved emergency plan. In any case, a spill or leakage of less than 15 bbls. requires a report from the operator as to the nature of the spill or leakage, why it occurred and what steps were taken to correct it. A spill of 15-20 bbls. must be reported by telephone immediately to GS and confirmed in writing. A spill of over 50 bbls, or one of any magnitude that cannot be immediately controlled, must be reported immediately to the Coast Guard and the Environmental Protection Agency as well as to GS.

b. Regional or National Contingency Plans

If the operator should be unable to control and remove the pollution, the Regional or National Oil and Hazardous

---

1/ See Attachment A.

Substances Pollution Contingency Plan may be activated and the designated Federal On Scene Coordinator would direct control and clean-up operations at the operator's expense. This has never been necessary in the case of any spill from OCS operations to date.

The Regional or National Oil and Hazardous Substances Pollution Contingency Plan was developed pursuant to the provisions of the Federal Water Pollution Control Act as amended (33 U.S.C. 1101). (EPA has published the revised National Oil and Hazardous Substance Pollution Contingency Plan as required by the Federal Water Pollution Control Act Amendments of 1972.) Section 11(c)(2) of that statute authorizes the President, within sixty days after the sections becomes effective, to prepare and publish such a Plan. The Plan provides for efficient, coordinated, and effective action to minimize damage from oil (and other) discharges, including containment, dispersal, and removal. The Plan includes (a) assignment of duties and responsibilities, (b) identification, procurement, maintenance and storage of equipment and supplies, (c) establishment of a strike force and emergency task forces, (d) a system of surveillance and notice, (e) establishment of a national center to coordinate response operations, (f) procedures and techniques to be employed in identifying, containing, dispersing and removing oil, and (g) a schedule identifying dispersants and other chemicals that may be used in carrying out the Plan, the waters in which they may be

used, and quantities which may be safely used. 1/ The Plan is revised from time to time as necessary. Operation of the National Contingency Plan requires a nationwide net of regional contingency plans. Guidelines for that nationwide net are established in the National Plan. This plan provides for a pattern of coordinated and integrated responses to pollution spills of departments and agencies of the Federal Government. It establishes a national response team and provides guidelines for the establishment of regional contingency plans and response teams. The Plan also promotes the coordination and direction of Federal, State, and local response systems and encourages the development of local government and private capabilities to handle such pollution spills.

The objectives of the Plan are: to develop appropriate preventive and preparedness measures and effective systems for discovering and reporting the existence of a pollution spill; to institute promptly, measures to restrict further spread of the pollutant; to assure that the public health, welfare, and natural resources are provided adequate protection; to provide for the application of techniques to clean up-and dispose of the collected pollutants; to provide for a scientific response to spills as appropriate;

1/ Annex X of the Plan basically sets forth a no dispersant policy. Exceptions can be made for safety reasons (to prevent fire or explosions) or for certain other circumstances such as the protection of endangered waterfowl. However, the approval of EPA is required, except in case of safety when the approval of the On-Scene Coordinator is required.

to provide strike forces of trained personnel and adequate equipment to polluting spills; to institute actions to recover clean-up cost; and, to effect enforcement of existing Federal statutues and regulations issued thereunder. Detailed guidance toward the accomplishment of these objectives is contained in the basic Plan, the annexed, and the regional plans.

The Plan is effective for all United States navigable waters including inland rivers, Great Lakes, coastal territorial waters, and the contiguous zone and high seas beyond this zone where a threat exists to United States waters, shoreface, or shelf-bottom. Its provisions are applicable to all Federal agencies.

A memorandum of understanding between the Departments of the Interior and Transportation outlines the respective responsibilities of the Geological Survey and the Coast Guard under the National Contingency Plan. GS is responsible for the coordination and direction of measures to abate the source of pollution when the source is an oil, gas, or sulphur well. This responsibility includes the authority to determine whether pollution control operations within a 500 meter radius of the pollution source should be suspended to facilitate measures to abate the source of pollution. The Coast Guard is responsible for coordination and direction of measures to contain and remove pollutants, and shall furnish or provide for the On Scene Coordinator with authority and responsibilities as provided by the National Contingency Plan.

c. Petroleum Industry Contingency Actions

(i) Inventory of Known Resources Available for Emergency Oil Spill Control and Clean-Up

From the upper Texas Coast to the Mississippi Delta region offshore operators maintain a large inventory of various kinds of equipment that could be put to use on short notice for containing and cleaning up an oil spill and killing the source of the spill. This inventory includes 177 boats ranging from 30 foot crewboats to 165 foot utility and cargo vessels, 64 helicopters, 103 fixed-wing aircraft. For a complete inventory of oil spill containment and clean-up equipment see Vol. 2 Attachment J

(ii) Clean Gulf Associates

Clean Gulf Associates is a non-profit organization formed by thirty-three companies 1/ operating in the OCS. Their purpose is to provide for a stock pile of oil spill containment and clean-up materials for use by member companies in offshore and estuarine a-eas. Clean Gulf Associates has contracted, effective August 1, 1972, with Halliburton Services to supply equipment, materials and personnel necessary to contain

1/ These thirty-three member companies produce 98% of offshore petroleum.

and clean-up spills in the Gulf of Mexico to the limits of the OCS lying offshore and seaward of the States of Texas, Louisiana, Mississippi, Alabama, and Florida.

All of the tracts considered in this proposed lease sale fall within this area. Before any drilling commences, should this proposed sale be held, an inventory of pollution combatting equipment would be stockpiled at a strategic location. Should oil reservoirs be found and production ensue, a permanent base for containment and clean-up equipment will be established. For a special stipulation concerning oil spill containment and clean-up equipment available in the proposed sale area see Section V.D.1.

At the present time, Halliburton maintains four types of recovery/clean-up systems for development at two primary bases located at Intercoastal City, and Grand Isle, Louisiana, and a sub-base at Venice, Louisiana and include:

(1) Fast response open sea/bay skimmer system

(2) High volume open sea skimmer system

(3) Shallow water skimmer system

(4) Auxiliary shallow water and beach clean-up equipment.

For a complete inventory of oil spill containment and clean-up equipment see Vol. 3 Attachment J.

B. Structures

If a ship strays from established safety fairways, oil and gas platforms can pose a hazard to commercial shipping. This hazard, however, is minimized by the fact that safety fairways are clearly designed on navigation charts. Directional drilling from outside safety lanes is used to develop tracts lying partially in safety lanes. Pertinent portions of the Federal Regulations (33 CFR Sec. 209.135(b), 1971), governing shipping fairways and anchorage areas are as follows:

> "The Department of the Army will grant no permits for the erection of structures in the area designated as fairways, since structures located therein would constitute obstructions to navigation. The Department of the Army will grant permits for the erection of structures within an area designated as an anchorage area, but the number of structures will be limited by spacing as follows: The center of a structure to be erected shall be not less than two (2) nautical miles from the center of any existing structures. In a drilling or production complex, associated structures shall be as close together as practicable having the consideration for the safety factors involved. A complex of associated structures, when connected by walkways, shall be considered one structure for the purposes of spacing. A vessel fixed in place by moorings and used in conjunction with the associated structures of a drilling or production complex, shall be considered an attendant vessel and its extent shall include its moorings. When a drilling or production complex includes an attendant vessel and the complex extends more than five hundred (500) yards from the center of the complex, a structure to be erected shall be not closer than two (2) nautical miles from the near outer limit of the complex. An underwater completion installation in an anchorage area shall be considered a structure and shall be marked with a lighted buoy as approved by the United States Coast Guard."

Development of the tracts in this proposed sale which lie partially within shipping fairways or anchorage areas if leased will be subject to Federal regulations as presented above so far as placement of structures is concerned and this would help mitigate any potential impact due to the proximity of structures to relatively high frequency sea traffic.

Commercial vessels are required to report to the Coast Guard whenever a casualty results in any of the following: (a) actual physical damage to property in excess of $1500, (b) material damage affecting the seaworthiness or efficiency of a vessel, (c) stranding or grounding, (d) loss of life, (e) injury causing any person to remain incapacitated for a period in excess of 72 hours; except injury to harbor workers not resulting in death and not resulting from vessel casualty or vessel equipment casualty. Drilling and production platforms (artificial islands) are required to report to the Coast Guard when involved in a casualty or accident and if any of the following occur: (a) if hit by a vessel and damage to property exceeds $1500, (b) damage to fixed structure exceeds $25,000, (c) material damage affecting usefulness of lifesaving or fire-fighting equipment, or (d) loss of life.

Under some conditions, offshore structures are an obstacle to commercial fishing activities. Depending on currents and underwater obstacles an offshore structure can remove areas of trawling and purse seining waters. Heavy concentrations of platforms can make trawling and purse seining difficult.

The erection of more structures on the OCS may affect commercial fishing operations. The impact from platforms may be kept to a minimum, however, by only allowing those structures necessary for proper development and production of the mineral resources, and by placing them with due regard to fishing operations and other competing uses which are evident at the time of platform approval.

The Area Oil and Gas Supervisor considers the views of commercial fishing organizations such as the Gulf State Marine Fisheries Committee with regard to placement of platforms. The Supervisor also from time to time requests information from the Department of Commerce, National Oceanic and Atmospheric Administration, and National Marine Fisheries Service to be used in his decision-making process of approving or disapproving platform installation. Within the constraints of location of the reservoirs and the technology necessary to drill directional wells, the Supervisor is mindful that platform location is an important consideration for commercial fisheries and does make decisions to minimize the impact of platform location on the commercial fishing industy.

In an effort to further mitigate the impact of offshore structures resulting from this proposed sale with regard to commercial fishing and other significant existing or future uses of the leased area, a lease stipulation giving effect to the following will be applied to all blocks in this proposed offering in the event they should lease:

"Structures for drilling or production, including pipelines, shall be kept to the minimum necessary for proper exploration, development and production and to the greatest extent consistent therewith, shall be placed so as not to interfere with other significant uses of the Outer Continental Shelf including commercial fishing. To this end, no structure for drilling or production, including pipelines, may be placed on the Outer Continental Shelf until the Supervisor has found that the structure is necessary for the proper exploration, development, and production of the leased area and that no reasonable alternative placement would cause less interference with other significant uses of the Outer Continental Shelf including commercial fishing. The lessee's exploratory and development plans, filed under 30 CFR 250.34, shall identify the anticipated placement and grouping of necessary structures, including pipelines, showing how such placement and grouping will have the minimum practicable effect on other significant uses of the Outer Continental Shelf, including commercial fishing.

C. Pipelines

The potential impacts of each specific nearshore and coastal pipeline construction project are considered by the Department in its review of Corps of Engineers permit applications.

Data concerning the miles and sizes of pipes needed, proposed routes, amount of dredging anticipated, cannot be determined until such time as the exact location of production has been delineated. The Department will conduct an environmental analysis on any application for a pipeline right-of-way that it receives. If it is determined that a pipeline right-of-way will have a major impact on the marine or coastal environment then an environmental statement will be prepared.

All interstate gas pipeline companies are subject to the jurisdiction of the Federal Power Commission under the Natural Gas Act. As part of its responsibility to the requirements of the National Environmental Protection Act of 1969, FPC has established extensive regulations relating to pipeline construction under its jurisdiction Detailed guidelines are established for the applicants preparation of an environment report to support an application for Public Convenience and Necessity. Pursuing its role as the lead government agency, FPC then prepares a Draft Environmental Statement.

The adverse effects associated with pipeline installation can be substantially reduced with adequate planning and by using the most appropriate construction techniques. For example, it may be

possible to use existing pipeline canals when laying new pipelines so that adverse impacts are restricted to fewer locations. Where wetlands are involved, pipelines can come ashore on elevated terrain to minimize damage to marshlands. Also in wetland areas, bulkheads usually are placed in canals to prevent salt-water intrusion and to maintain existing drainage and water-exchange routes. To protect oysters, pipelinesusually are routed around major oyster reefs, and where shallow estuaries are to be crossed, the canal usually is backfilled; in many cases so are canals through marshlands. Although all of these measures help to mitigate the problem, the impact of pipeline installation on the coastal environment requires the joint effort of many agencies and industry for successful resolution.

Agencies having responsibility or jurisdiction over all or part of oil and gas pipeline installation or operation in coastal areas are: (1) Department of the Interior, (a) Bureau of Land Management --rights-of-way for common carrier pipelines on the OCS, (b) Geological Survey--jurisdiction over producer owned gathering lines and flowlines on the OCS, (c) Bureau of Sport Fisheries and Wildlife--protection of fish and wildlife resources and their habitat through consultation with the Corps of Engineers in the process of issuing Federal permits in navigable waters; (2) U.S. Army Corps of Engineers—issues permits for construction (including pipelines) on OCS and in other navigable waters; (3) Federal Power Commission--grants certificates of convenience and necessity

prior to construction of interstate natural gas pipelines; (4) Interstate Commerce Commission--grants approval of the tariff rates for transportation of oil by common-carrier pipelines; (5) State of Louisiana--grants rights-of-way through navigable waters under State jurisdiction; (6) Department of Transportation, Office of Pipeline Safety--establishes standards for pipeline construction, operation and maintenance; and (7) Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service--protection of marine fishery resources and their habitat (in coordination with the Bureau of Sport Fisheries and Wildlife), through consultation with the Corps of Engineers in the process of issuing Federal permits in navigable waters.

At present the cooperative effort between the Department of the Interior and the Corps of Engineers, and the National Marine Fisheries Service and State conservation agencies is responsible for minimizing the impact of pipeline (and other) construction of navigable waters of the United States. The Corps of Engineers, through authority of the Rivers and Harbors Act of 1899, (33 U.S.C. 403), asserts authority over and requires a permit for, construction in all navigable waters subject to the Submerged Lands Act (43 U.S.C. §1301), and includes all lands permanently covered by tidal waters up to the line of mean high tide.

The Environmental Protection Agency reviews and comments on dredging projects in navigable waters in accordance with a Memorandum of Understanding with the Corps of Engineers, dated July 13, 1967.

The National Oceanic and Atmospheric Administration (through its National Marine Fisheries Service) has been vested with responsibility for participation in matters relating to marine and estuarine areas.

The Department of the Interior and its Bureau of Sport Fisheries and Wildlife has responsibility and authority under several statutes, including the Fish and Wildlife Act of 1956, the Estuary Protection Conservation Act, the Fish and Wildlife Coordination Act, the Marine Mammals Protection Act, and various international treaties enacted to preserve, conserve, protect and enhance fish and wildlife resources and their habitat.

The Bureau of Sport Fisheries and Wildlife, with assistance from appropriate State and Federal agencies, including the National Marine Fisheries Service now reviews all applications to the Corps of Engineers for permits to construct pipelines in navigable waters and assesses their potential impact on fish and wildlife resources and the environment. When appropriate, the Bureau recommends to the Corps specific modification of project plans

which are needed to reduce impact on these resources. Occasionally a project plan is so conceived that significant impact cannot be avoided, but at the same time, a satisfactory alternative may be available; in such cases, a recommendation that the permit not be issued would be appropriate. At least one court decision has indicated that the Corps of Engineers has the authority under the Rivers and Harbors Act to condition or deny a permit on the basis of environmental considerations. 1/

Much of the coastal lands outside of parks and refuges are privately owned, but wetlands that are below the line of mean high tide are subject to Federal regulation (as navigable waters) through application of the Corps of Engineers permit system.

Thus, Federal or State authorities or private land owners may require, depending upon circumstances and location, that pipelines be buried, that canals be backfilled where possible, that bulkheads be erected in marsh areas to prevent saltwater intrusion, the kind of dredging equipment to be used, the inclusion of shut-off valves, specific placement or disposal of spoil, or, in the case of a private landowner, that pipeline corridors be established.

1/ See Zabel v. Tabb, 430 F. 2n 199 (5th Cir. 1970).

The Offshore Pipeline Committee 1/ contracted with Battelle Laboratories to conduct a systematic, comprehensive study of the environmental effects of gas pipeline construction and operation in the Gulf Coast region with emphasis on the Louisiana marshlands. The study, which is now complete, is an attempt to document existing knowledge on environmental effects of pipeline construction and operation, to identify gaps in existing data, and to state conclusions, based on present knowledge, concerning the impacts of pipelining in the marshlands. The final report resulting from this study 2/ presents a description of gas pipelining operations, and of the natural and socio-economic environment, and analyzes the effects of gas pipelining on the physical, biological, and socio-economic facets of the environment.

1/ The Offshore Pipeline Committee is composed of ten interstate gas pipeline companies.

2/ McGinnis, J. T., et. al., 1972. Final Report on Environmental Aspects of Gas Pipeline Operations in the Louisiana Coastal Marshes to Offshore Pipeline Committee. Battelle, Columbus Laboratories, Columbus, Ohio.

D. Other Mitigating Measures

1. Special Stipulations

Leases for oil and gas exploration and development are subject to all OCS operating regulations and orders. Additionally, in some cases the lease may include special stipulations which are considered necessary for the protection of a particular resource, or activity, such as the one presented in Part B. above. These stipulations can be designed to meet the needs of a particular resource, e.g., wildlife or waterfowl refuges, fishing areas, certain recreation areas, protection of archeological or historical values, etc., which might be quite sensitive to development of the lease. In this proposed sale, it is believed the following suggested lease stipulations will help mitigate potential impacts on the resources identified below:

(1) It is proposed that the following stipulation be applied to any lease and to BLM-permitted pipelines resulting from this proposed sale for the protection of historical, or archeological, values:

> "The lessee agrees that, prior to any drilling activity or the construction or placement of any structure for exploration or development on the lease, including but not limited to well drilling and pipeline and platform placement (hereinafter referred to as "operation"), he will conduct geophysical surveys sufficient to determine the possible existence of any sites, structures, or objects of historical or archeological significance that may be affected by such operations. Such sites, structures, or objects are hereafter in this stipulation included in the term "cultural resource." If these geophysical surveys indicate anomalies that suggest the possible existence of a cultural resource, the lessee will either: (1) have a qualified marine archeologist confirm or refute the existence of a cultural resource using such other equipment and survey techniques as may be necessary; or (2) relocate the site of such operations, so as not to disturb the area in which an anomaly has been identified; or (3) show how such operations, will not disturb the area in which an anomaly has been identified.

All data obtained in the course of the geophysical and any archeological surveys shall be submitted to the Supervisor with any application for drilling or other activity. If the Supervisor determines there are indications that a possible cultural resource may be affected by the proposed operation, he shall direct the lessee to utilize the services of a marine archeologist to survey the area unless an archeological survey has been completed.

Upon completion of any archeological survey, a report shall be forwarded by the Supervisor to the Manager, Gulf of Mexico OCS Office, Bureau of Land Management for review and recommendations. Should the archeological survey report indicate that a cultural resource may be affected by the operation, and the lessee chooses not to relocate, the lessee shall take no action that may result in the disturbance of the cultural resource until the Supervisor has given directions as to its disposition.

The lessee agrees that, if any cultural resource should be accidentall discovered after the completion of the archeological survey, he will report immediately such findings to the Supervisor and make every reasonable effort to preserve and protect the cultural resource from damage until the Supervisor has given directions as to its disposition.

(2) In addition, it is proposed that the following stipulation be applied to any lease resulting from this proposed sale for protection of the environment:

"The lessee shall have the pollution containment and removal equipment available as required by OCS Order No. 7 of August 28, 1969, as may be amended. After notification by the Operator to the Supervisor of a significant oil spill as defined by OCS Order No. 7, or an oil spill of any size or quantity which cannot be immediately controlled, the operator shall immediately deploy the appropriate equipment to the site of the oil spill, unless, because of weather and attendant safety of personnel the Supervisor shall modify this requirement."

2. Notices to Lessees and Operators

These notices have the same effect or status as OCS Operating Orders and Regulations and are used when expeditious clarifications or corrections and additions to existing orders and regulations

are necessary. By issuing Notices to Lessees and Operators, the extensive amount of time necessary to amend and republich orders and regulations is avoided. One example of a Notice, issued December 11, 1972, explains and details conditions for approval of waste water (oil field brines) disposal from OCS offshore facilities. This Notice provides that such discharges shall meet applicable EPA or State standards for effluent limitations, whichever are more stringent, and provides for certain monitoring activities. The ban on offshore use of PCB's was implemented by such a notice. Minimum geophysical survey requirements to comply with the stipulation to protect archeological and historical resources are also the subject of a Notice to Lessees.

3. Departures

A departure (waiver) from OCS orders or other rules of the GS Supervisor may be granted when such a departure is determined to be necessary for (30 CFR, 250.12(b)):

a) the proper control of a well,

b) conservation of natural resources,

c) protection of aquatic life,

d) protection of human health.and safety

e) protection of property, or

f) protection of the environment.

Waivers are technically based decisions and are granted in situations only where expert judgment determines that better, safer operations would result from operations under the waiver.

4. Research on Advanced Technology

EPA and Coast Guard are conducting research on more effieicent containment and recovery devices (booms and skimmers). The efficiency of booms and skimmers depends on sea state and spill conditions but in any case are never 100% efficient. When the results of these studies, and any other similar studies so indicate, the requirement for use of better techniques and equipment will be incorporated into the OCS regulations and orders as appropriate. If incorporated, the requirements will be applied to all leases.

5. Geophysical Information

The Geological Survey is aware of the effects of the near surface geologic environment on drilling, fixed structural emplacements, pipelines, etc. This knowledge is fundamental to a sound lease management program for the OCS.

Geophysical data, which show the shallow structural and sedimentary environment, are used to predict, and thus minimize, any geologic hazards to drilling operations and consequent possible dangers to the environment, from pollution. Surface and shallow subsurface geologic strata, seldom create insurmountable obstacles to a minimal risk program of exploration and exploitation of economically attractive structures.

High resolution geophysical data covering all tracts to be offered for sale will be purchased and analyzed by GS geophysical personnel. These data, in the area of coverage, provide definitive information on (1) thickness of the unconsolidated sediments (0-300 feet); (2) structural configuration on shallow seismic horizons (300-500 feet below ocean bottom); (3) sea floor anomalies, mud mounds, mud waves or potential slide areas; pipeline and other objects on the sea floor, and bore hole locations as interpreted from a combined analysis of several geophysical measurements, and (4) bathymetry.

Information from these high resolution data are extremely useful in detecting shallow geologic hazards such as potentially unstable bottom conditions (mud waves, etc.), shallow faults, and in some cases, near surface gas pockets. When these features are identified prior to drilling operations, or platform construction, the operator is notified so he can take the necessary action to assure that his operation is conducted with maximum safety. This is a necessary part of an effective OCS lease management program.

High resolution geophysical data usually are not gathered until the tracts to be offered for lease are announced and therefore, they are not available at this time to contribute to a preliminary near-surface analysis; however high resolution data will be available prior to the sale date to support both pre- and post-sale lease management activities.

The latest interpretation of high resolution bottom profile data will disclose any bottom and/or subsurface conditions that might pose special environmental hazards for drilling or producing operations in the Louisiana offshore area, and these will be made available to the Bureau of Land Management OCS Manager prior to his decision to issue a lease and to the Geological Survey Area Supervisor prior to his approval of drilling operations. The District Engineer, Geological Survey, will prohibit the location of platforms on areas of instability should the need arise, through his authority to issue or not issue permits for platform placement.

6. Conservation Practices

The Oil and Gas Supervisor, in the interest of conservation, is authorized pursuant to the Code of Federal Regulations, to approve well locations and well spacing programs necessary for proper development giving consideration to such factors as the location of drilling platforms, the geological and reservoir characteristics of the field, the number of wells that can be drilled economically, the protection of correlative rights, and the minimizing of unreasonable interference with other uses of the Outer Continental Shelf. The Supervisor draws his authority from the following regulations and OCS operating orders:

30 CFR 250.11 outlines in broad terms the Supervisor's authority to control development of the OCS to protect the environment, and to obtain maximum economic recovery of mineral resources under sound conservation practices.

30 CFR 250.16 authorizes the Supervisor to specify the permissible production of a well. Thereafter, OCS Order No. 11 establishes the production rate control at the Maximum Efficient Rate (MER) of the well or reservoir. MER is defined in OCS Order No. 11, see Attachment G.

30 CFR 250.17 dealing with well spacing authorizes approval of well locations, platform locations, and lists factors for consideration in this regard.

30 CFR 250.30 requires lessee's compliance with OCS Orders as well as general regulations and demands all necessary precautions to prevent damage, waste, and injuries.

30 CFR 250.34 requires the lessee to submit to the Oil and Gas Supervisor exploratory drilling plans, lease development plans and applications for permits to drill prior to these drilling programs. The Oil and Gas Supervisor utilizes well information such as electric well logs, core information from other wells previously drilled in the vicinity of the proposed drilling program and geological and geophysical data and other pertinent reservoir information to determine the proper number of wells necessary for development.

30 CFR 250.50 grants the Director authority to demand pooling or unitization which the Secretary is authorized to require under the OCS Lands Act in the interest of conservation.

30 CFR 250.51 refers to the unit plan regulations contained in 30 CFR 226 with regard to obtaining approval of units or cooperative agreements.

30 CFR 250.52 lists purposes for which the Supervisor may approve pooling or drilling agreements.

7. Other Requirements

In addition to the Interior Department's requirements, the operator must comply with applicable navigation and inspection laws and regulations administered by the U. S. Coast Guard. These relate to safety of personnel and display of prescribed navigational lights and signals for the safety of navigation. Permits to install islands and fixed structures and the drilling of wells from mobile drilling vessels must also be obtained from the U. S. Army Corps of Engineers, which is authorized by the OCS Lands Act to prevent obstruction to navigation. The decision as to whether a permit will be issued by the Corps of Engineers is based on an evaluation of the impact of the proposed work on the public interest. Factors affecting the public interest according to the Corps of Engineers include, but are not limited to, navigation, fish and wildlife, water quality, economics, conservation, aesthetics, recreation, water supply, flood damage prevention, ecosystems, and, in general, the needs and welfare of the people. Pipeline construction must also be in compliance with

standards established by the Office of Pipeline Safety, Department of Transportation. The Department of Labor establishes Occupational Safety and Health Standards which are applicable to OCS operations.

Operators must comply with requirements of the Federal Water Pollution Control Act Amendments of 1972 (P. L. 92-500; 86 Stat. 816) which establishes a National Pollutant Discharge Elimination System 40 CFR Part 125, 38 F. R. 13528 (1973). This system applies to discharges on the OCS from any point source and requires any person to obtain a permit from the EPA for the discharge of any pollutant as defined by the Act. Discharges of any pollutant without the necessary permit from EPA is made unlawful by the Act. Pursuant to section 501(b) of the Act, the Department of the Interior has suggested to EPA that the feasibility of a memorandum of understanding between the two agencies be considered in order to facilitate the administration of the NPDES as it applies to discharges arising from OCS lease operations and to minimize any redundancy of efforts by the Geological Survey and EPA. The feasibility is currently still under consideration.

VI. UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

As described in Vol. 1, Sec. III. B. of this statement, certain features of oil and gas operations cause adverse effects which may be considered unavoidable in the light of current operation practices, technology, and regulations. A capsule summary of the significant effects from this sale are identified below. In addition, although oil spills resulting from this proposed sale can in general be avoided, some of the effects of an oil spill, if one should occur, are considered unavoidable and are also discussed below.

A. Effect on Marine Organisms

Several oil and gas operations result in temporary increases in turbidity. These operations include the discharge of drilling fluids and the excavation of pipeline trenches by jetting and dredging. When turbidity is generated near the water surface, the depth of penetration of sunlight is diminished. This leads to a decrease in the output of the photosynthetic mechanism of the phytoplankton. The dimensions of the area affected are small and consist of a plume hundreds of yards in length. The duration of the turbidity in a given location will be several hours if the source is pipeline burial operations, and several weeks to several months if the source is drilling fluid discharge. The effect of any decrease in primary production must be considered adverse. The area involved is very small and any reduction would only occur locally and would not involve the entire population of marine organisms.

Clogging of respiratory surfaces and filter-feeding mechanisms could reach a severe level in the benthic animals, however. The result of turbidity will be physiological stress, and possible mortality. This impact will be encountered during pipeline jetting operations and will be restricted to the downstream direction of the ocean current. The duration of the impact in a given area will be no longer than a few hours, but if it occurs in shellfish beds and similar concentrations of organisms the impact would be considered adverse.

Beneath every platform where wells have been drilled is an expanse of cuttings, released during drilling, which has buried and smothered all non-motile benthic forms below it. If it is different in texture and composition from the surrounding sediment, it will not likely be colonized by local forms.

Exposure of biota to harmful or toxic materials released into the marine environment or coastal marsh such as from accidental spills of crude oil, fuel and solvents, and the routine discharge of formation waters will bring about an adverse effect if this occurs. The effects of heavy concentrations of crude oil and petroleum derivatives, depending on their composition, consists of lethal toxicity, sublethal effects, coating with weathered oil, behavioral changes, and habitat changes. The more subtle effects of light contamination may be serious also, but are not well understood at this time. Some specific types of this effect are:

1. Marine phytoplankton have been shown to suffer stress and mortality when exposed to oil during laboratory experiments.

2. Copepods have been found ingesting and passing oil droplets without apparent harm. The copepods, however, serve as an important link in the food chain between phytoplankton and larger animals and ingested hydrocarbons are therefore passed on to larger organisms.

3. All marine plankton present near the core of the plume of formation water, before it is sufficiently diluted by sea water, will suffer stress or mortality from concentrations in the plume. This adverse effect will be immeasurably small at the population level.

4. Laboratory experiments show that fish may be killed during the egg and larval stage after exposure to crude oil. Respiratory surfaces become clogged and damaged in juvenile and adult stages. These effects would occur if spills come in contact with eggs and larvae in the breeding zones.

5. In the event of an onshore oil pipeline leak or spillage on onshore facility, vegetation would be affected according to the severity of the spill. A small leak may do little damage. A severe leak however, may contaminate the substrate and kill the vegetation that comes into direct contact with the oil and several years may be required for recovery. Small animals in contact with the oil would likely be killed.

6. Although large numbers of bird deaths have not been a feature of past oil spills in the Gulf of Mexico, the probability is high that if a large spill comes ashore in the western Gulf, that large numbers

of shorebirds, wading birds, and waterfowl will be killed-- an exceedingly adverse impact.

Although the potential for harm is present, the inability to predict accidental oil spills makes an assessment of the scope of the effect on birds uncertain.

Damage to immobile, attached, and rooted organisms during excavation and reworking of sediments and soil, and suspension of sedimentary materials can occur from entrenching of subsea pipelines, burial of pipelines through beach and where applicable, adjacent coastal wetlands. During emplacement of subsea pipelines, sediments and benthic animals are washed out by hydraulic jetting. Softer life forms are likely killed, others are made vulnerable to predation, and in immediately adjacent areas of down stream ocean currents, some burial and smothering could be expected. The effect is limited to local areas around drill holes and pipeline paths. In these areas, the effect is adverse and unavoidable.

B. Wetlands and Beaches

Disturbance of beach and wetlands biota during pipeline burial by the trench and backfill method, uproots all plants and non-motile animals in the path of the pipeline, leaving a barren strip several feed wide. Some slight damage may also be rendered to vegetation in adjacent areas by machinery used in the operation. The effect is localized, but adverse for the smaller organisms destroyed.

If an oil spill impacts upon a beach then there will be an adverse effect, which may last from weeks to several years or more, depending on the amount of oil and size of the area impacted. Heavily contaminated beaches will be rendered unsuitable for recreation so long as they remain contaminated with oil. If mechanical means are employed in beach clean-up operations (bulldozers, front end loaders and other earth moving equipment) as was done following the Santa Barbara and Arrow oil spill incidents, then shoreline equilibrium may be upset by beach removal. Excessive removal of beach materials can lead to erosional problems unless enough sand and gravel, or other suitable replenishing material is available to replace the removed beach materials.

C. Deterioration of Air Quality

Air quality will not be seriously impaired by routine operations, however, degradation could result from several types of accidents.

If a natural gas leak or gas well blowout should occur, degradation would be minimal. Pollution would be mostly from methane which quickly disperses and drifts away. If a fire results, pollutants would be largely carbon dioxide and water vapor.

Oil leaks and oil spills not accompanied by a fire, would introduce highly volatile, low molecular weight hydrocarbons, such as benzene - and toluene, into the atmosphere. These lighter fractions of crude oil would undergo some unknown degree of degradation, but resultant photochemical smog is one possibility. If the spill results in a fire, large amounts of particulate carbon, and oxides of carbon, along with smaller but unknown amounts of sulfur oxides, nitrogen oxides, evaporated crude oil liquids, and partially oxidized compounds, would enter the air. Local air quality would be severely degraded during the period of the fire. This effect, should a fire occur, would be considered adverse and unavoidable.

D. Deterioration of Water Quality

Degradation of water quality by routine operations will be minimal. Brines added to sea water quickly diffuse into the water column.

Moderate to severe degradation would occur, however, in the event of an accidental oil leak or spill. The effects of water quality degradation on the biotic community would be the major concern if this occurred. As with all accidents the possibility exists, and if it

should occur, the effect would be adverse. In addition, water quality degradation will occur onshore if produced waste water is transported to shore for treatment and then discharged into fresh or brackish water systems which is the case when operators fail to follow state water quality standards.

E. Interference with Commercial Fishing Operations

As described in earlier sections, trawling operations suffer interference and inconvenience from oil and gas operations in several ways. A small portion, up to 0.3% of each tract leased, of sea floor is occupied by drilling rigs and platforms and is unavailable to trawl fishermen. Based on past exploration success rates, up to 1425 acres of sea floor may be occupied by platforms resulting from this proposed sale. Trawl nets, reportedly become snagged on underwater stubs and unburied pipelines, causing damage to, or loss of, the nets. Less frequently, large objects lost overboard off petroleum industry boats and platforms are caught in trawling nets, resulting in damage to the net and/or its catch of fish. The frequency of occurrence of this type of incident is unknown.

Although commercial fishermen could be expected to get out of the area of an oil spill, spilled oil could coat or contaminate commercial fish species, rendering them unmarketable. This would be another adverse effect to commercial fishing.

F. Interference with Ship Navigation

Very little interference can be expected between drilling rigs and platforms and ships that are utilizing established fairways. However, at night, and especially during rough weather, fog, and heavy seas, ships not navigating the fairways could collide with fixed structures. Also fishing boats engaged in trawling will be inconvenienced by having to navigate around fixed structures located on fishing grounds. Based on past exploration success rates, up to 200 new platforms could result from the proposed sale. Added to the 2,100 platforms now in the Gulf of Mexico the increment is small but still represents a potential increase in possible interference with shipping.

G. Damage to Historical and Archeological Sites, Structures and Objects

Should an archeological or historical site on the OCS evade detection by the geophysical surveys required (see stipulation in section V.D.1.), pipeline burial or the construction of a platform could damage the site. However, the above mentioned surveys are designed specifically to keep the occurrence of this type of damage to a minimum.

Other damage to archeological resources could come from oil contamination. Historical and archeological materials soiled by an accidental oil spill may not survive subsequent cleaning and restoration efforts. Porous materials could be rendered unsuitable for carbon dating

techniques. Although the probability of such an incident occurring does exist, the potential for significant historical resource destruction appears small, although it does exist.

H. Interference with Recreation Activities

Interference with recreation is closely related to degradation of aesthetic values. Oil contaminated beaches, freshly cut pipeline routes, terminals, and other onshore support facilities would normally be avoided by those seeking recreation sites for use or development. Disturbance of beaches by pipeline burial operations is very short-lived, relative to recreational use. Oiled beaches may require days, weeks, or years for adequate restoration depending on the initial severity.

I. Degradation of Aesthetic Values

It is possible that some portion of platforms and drilling rigs constructed or used on 78 tracts included in this proposal, and located 17 miles or less from the mainland or the barrier islands coastline, will be visible to the naked eye of a shoreline viewer. A few onshore pipeline terminals and treatment facilities will be constructed as a result of this proposed sale. If these objects interfere with residential or recreational vistas, the visual effect would probably be considered adverse. The incremental addition to what exists in the region is small, therefore, the impact is considered to be minimal. A number of the 78 tracts are seaward of uninhabited or non-usable coastlines, for instance, immediately off the Mississippi

River delta. Construction of platforms or rigs on these tracts will have little or no aesthetic impact.

Spilled oil and debris floating in the water or washed up on the beach would also detract severely from the scenic values of any local area. Before the natural terrain and vegetation has been completely restored, the effects of pipeline burial will appear as a large scar traversing the beach and coastal area. Restoration of the scar will require at least one year.

J. Conflict with Other Uses of the Land

If sited in agricultural areas, the construction of pipeline terminals, or other onshore facilities will remove temporarily small amounts of land from grazing or farming use. Interruption of farming activities until the following growing season usually results. The existence of pipeline terminal facilities would involve the permanent loss of up to several acres for grazing or farming, because each facility usually requires an access highway and is enclosed by a fence. A pipeline leak, however, involving the release of oil into farm land would render the land contaminated and unsuitable for grazing or other agricultural purposes. One to several growing seasons might be required for recovery of affected vegetation and degradation of spilled oil. The low probability of this occuring and the relatively small areas involved, indicate it is minor, although were it to occur it would be considered adverse.

K. Summary

In summary, all unavoidable adverse impacts that will be sustained by the natural environment as a result of routine operations will be relatively localized in their effects. Many will be followed by unhindered natural recovery within relatively short time periods. A massive accidental oil spill could result in severe and widespread damage of major consequence. Therefore, all the tracts identified for oil and gas production in this proposed sale do contain varying degrees of potential for adverse effects of several kinds. Only a massive oil spill accident is considered to result in significant adverse impact; the probability that such a spill will occur, however, is relatively low (see section III. A.).

VII. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The principal short-term use of the proposed sale area will be the extraction of oil and gas from those tracts which prove economically productive. This mineral extraction will contribute to the diminishment of the long-term productivity of the oil and gas resources of the Gulf of Mexico and possibly to marine and coastal resources.

Oil and gas have been extracted from Louisiana OCS areas for many years, and, although no decrease in marine productivity has been detected, it is recognized that chronic low-level pollution from oil and toxic chemicals may impact adversely on long-term productivity. It is possible that development of the incremental OCS area in this proposed sale will result in degradation of long-term productivity, but the long-term effects of low-level pollution are not clearly understood at this time.

The additional stress which the ecosystem can absorb is limited, but at present, the bounds of these limitations are not known. St. Amant observes, "Certainly the significance of the continual addition to, and accumulative effect of, sublethal pollutants in the environment is probably the most important ecological question facing us today." 1/

It is not anticipated that other impacts not mentioned above caused by oil and gas operations will decrease either short-term or long-term productivity of the ocean.

1/ St. Amant, Lyle S., "Biological Effects of Petroleum Exploration and Production in Coastal Louisiana", Louisiana Wildlife and Fisheries Commission, December 1970, p. 20.

Disturbance of coastal land by pipeline construction and burial operations and construction of related onshore facilities will decrease productivity in the short-term only. Productivity of coastal lands in the area disturbed by pipeline operations will actually increase following the disturbance, and will fall off to natural levels as original conditions are restored in subsequent growing seasons. During the restoration period, light grazing or farming pressure most likely will not have any effect, but heavy grazing or farming could serve to keep the disturbed area from recovering at an optimum rate. Species diversity in the disturbed area will be low during the recovery period.

Based on past leasing and exploration experience, as many as 200 new platforms will be constructed as a result of this proposal. More and more structures are required as OCS production increases, and although concomitant cessation of production in older fields results in removal of some platforms, the cumulative impact of structures on multiple-use of the OCS is a point of concern. The cumulative impact of structures as hazards to commercial shipping, and as obstruction to commercial fishing activities, represents a conflict that can be controlled through proper planning and coordination with the appropriate Federal and state agencies and private industry. Some leveling out in the number of platforms is expected as older fields become inactive or hydrocarbon production decreases. This is also true with regard to the cumulative numbers and length (in miles) of

pipelines coming ashore. In the case of pipelines, as more and more areas begin to approach termination of production, some additional capacity will be available in existing pipelines to carry production from new areas thereby reducing the numbers of new pipelines required from subsequent lease sales. We are unable to determine at this time if the total number of platforms and pipelines required to develop the OCS areas in the Gulf of Mexico has peaked, but indications are that conditions are approaching a leveling off point.

From the information at hand, long-term productivity of the Gulf environment, we believe, is not being reduced.

VIII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

A. Mineral Resources

Leasing of the proposed tracts in this sale would permit development and extraction of the minerals contained therein. This lease sale could result in production of between 300 and 700 million bbl. of oil and 5 to 11 trillion cubic feet of gas which would represent an irreversible and irretrievable commitment of mineral resources.

B. Land Resources

It has been estimated that there will be expansion of onshore facilities as a result of this proposed sale. Some new pipelines will be required offshore and it is oossible that one new pipeline may have to come ashore (industry estimate), with an appropriate terminal. Geological Survey has estimated that 0-5 new onshore terminals will be necessary to handle the anticipated production from this proposed sale. Any onshore or coastal zone construction would involve the irretrievable commitment of several acres of coastal lands for driveways and station or facility sites.

C. Fish and Wildlife Resources

An irreversible for irretrievable commitment of fish and wildlife resources and their habitats could occur in the area of a massive oil spill or if frequently subjected to chronic low-levels of oil pollution. At this time, there is insufficient evidence to conclude that low-level spillage has led to an irreversible commitment of fish and wildlife resources but there is enough evidence to indicate that this is a possibility that deserves close attention, and constant study.

D. Cultural Resources

Archeological resources (sites of prehistoric habitation) and historical resources (shipwrecks) may be irretrievably lost if badly damaged by pipeline construction or construction of production platforms. However, we know of no instance of such damage resulting from OCS operations, and the mitigating measures outlined in section V.D.1. are designed to prevent such an irretrievable loss.

IX. ALTERNATIVES TO THE PROPOSED ACTION

A. Hold the Sale in Modified Form

1. Details of Tract Selection Process for Proposed Louisiana Sale

The Louisiana call for nominations resulted in approximately 5,300,000 acres (1100 blocks) being nominated by 28 companies out of over 17 million acres available. 1/ The 5,300,000 acres were reduced to a logical, reasonable sale size (approximately 1.4 million acres), as determined by present Departmental guidelines to lease 3 million acres per year.

Three primary leasing objectives or Departmental goals have been established for the OCS program. These objectives are: orderly resource development, protection of the environment, and receipt of fair market value. These three objectives are necessarily broad, but require specific application in the tract selection process.

These general categories were specifically applied as follows:

a. Nominations and Past Leasing History

The weighted nominations, history, and other pertinent data were reviewed by the BLM New Orleans Office.

The nominations were analyzed to identify implied geologic structures, the history analyzed to determine if interest in specific tracts had increased, lessened or was the same as to nominations received in the past.

1/ The approximate total unleased acreage of Federal land offshore Louisiana between State waters and the 600 meter isobath.

b. Geology

On January 8 a meeting was held between BLM New Orleans and GS Metairie to discuss tracts which BLM had previously identified to GS as initial recommendations. GS had reviewed the tracts using available geological and geophysical data.

In the great majority of cases their data confirmed the initial recommendations as determined by analysis of nominations.

In cases where there appeared to be a difference between interest, as expressed by nominations, and GS data, specific structural maps which GS had available for the proposed sale area were reviewed. These maps, for the most part, consisted of small scale composite structural maps (approximately 1" to 3 miles). Also, specific wells which potentially affected some of these blocks were discussed as to amount and type of production, if any. In some cases where larger scale field maps were available (approximately 6" to 3 miles), these were also used by GS in their presentation to BLM.

c. Environmental Considerations

The preliminary environmental analysis was presented in the general form of physical, resource and socio-economic profiles, using map overlays and written documentations.

The categories of information presented include:

1. Ocean currents and Winds
2. Basic Geology
3. Bottom Sediments
4. Hazards
5. Outdoor Recreation
6. Sport fishing
7. Commercial Finfish
8. Commercial Benthos
9. Commercial Shrimp
10. Threatened Species
11. Upland Wildlife
12. Upland Birds
13. Waterfowl Concentrations
14. Livestock and Grazing
15. Transportation
16. Lands and Waters of Ecological Importance
17. Lands "Suitable" for Development
18. Socio-Economic

The above basic information was then interpreted as to the potential impact on, or hazard to, the individual resource from offshore drilling and development, pipeline construction and oil spillage. From these interpretations "potential environmental hazard zones" were developed for use in the tract selection process.

Other factors considered were as follows:

d. Special Considerations

(1) Defense Warning Areas

No warning zones were identified which affected the area so no possibility of conflict between leasing and warning area uses was considered.

(2) Sales Size

Departmental guidelines, based on supply-demand and potential reserve estimates, have established approximately 1,400,000 acres as the sale size. The tract selections in this case conform to those guidelines.

(3) Deepwater Tracts

Our selection of "deepwater" tracts totalling approximately 430,000 acres is deemed appropriate within the tract selection guidelines.

All so-called "deepwater tracts" selected are logical extensions of adjacent acreage in the older mapped area and should provide no insurmountable problems for exploration and production.

(4) Other

Consideration in tract selection was given to economics, including industry economics, national economics, and regional economics.

The high industry interest in offshore Louisiana, measured by level of nominations, expresses industry's desire to explore and develop this area. Special attention was given to tracts receiving a large number of nominations because this is an indicator that several companies view these tracts as having economically feasible production potential. For this reason, number of nominations received is always an important factor in tract selection.

The proposed leasing of Louisiana tracts is an item on the tentative five-year schedule. The schedule attempts to relate timing, size and location of each sale to the projected national needs for hydrocarbons. Production from this area would, to an extent, lessen our import needs and thereby ease the balance of payments strain. As to the choice of specific tracts in the tract selection process, the objective of orderly resource development received high priority. An attempt was made to select desirable tracts over a large area so that if and when they are leased, our geologic information and knowledge of type and extent of production will be greatly increased for planning future sales.

The economic and institutional factors taken into consideration in the tract selection process for OCS Sale No. 36 are contained in the regional economic and land use profiles developed by the Regional Planner in the Division of Environmental Assessment. This treatment is a part of the environmental profiles developed for the entire Gulf of Mexico by the New Orleans Office.

Factors considered include regional refining capacities and present production, transportation and processing facilities.

In summary the tracts selected for further consideration for leasing and analyzed for potential environmental impact in this statement are believed at this time to have the highest geologic potential for oil and gas production, highest estimated reserves and offer the most efficient resource exploitation. The potential environmental impact of leasing these tracts has been previously described in this impact statement.

2. Sale Modification Alternatives

a. Delete Tracts

The proposed sale could be modified by offering only those tracts estimated to be gas producing and would avoid some of the potential adverse environmental effects related to this proposed sale. It would eliminate or significantly reduce the potential hazard to the environment from possible oil pollution events that could result from this sale as proposed.

With this modification, the proposed sale could go forward with very little, if any, adverse impacts expected as a result of oil pollution on the marine and coastal environments, the resources, and related activities of the area offshore.

Elimination of these tracts would result in the loss to this sale of the 300-700 million bbl. of the estimated recoverable reserves for oil which would have to be made up from some other source.

However, development of gas prone tracts only would still require seismic exploration, exploratory drilling, construction of permanent platforms and pipelines, production well drilling, workovers, maintenance and repair work with the attendant potential adverse environmental impacts discussed in detail throughout this environmental statement for those activities. If this alternative is followed, the overall importance associated with these activities with regard to the environment would be essentially the same as it would be if all the proposed tracts were offered. However, the magnitude of potential impacts would be reduced and the cumulative impacts associated with quantities of waste water effluents and debris, and the numbers of platforms and pipelines required to develop gas prone tracts only would be lessened. With this alternative the environmental effects of pipelines, as previously discussed, would apply, but instead of a maximum of 1300 miles of pipelines needed to develop the tracts, possibly only 1000 miles would be required.

Another alternative would be to delete tracts strictly on the basis of depth. If all tracts in water depths of 200 meters or beyond were deleted, 430,000 acres would be eliminated.

The environmental impact of this possible modification would be to reduce the risk of oil spills from two sources: 1) the normal risk associated with standard operations, and 2) the additional incremental risk associated with development in deep water, for which technology has not been fully tested. Deletion of deep water gas tracts would insignificantly alter the potential environmental impact of the entire proposed sale.

An additional consideration regarding the technology of deep water operations is that, since deep water tracts have been offered and leased previously (Louisiana General Lease Sale #33), deep water tracts should not continue to be offered until industry develops these presently leased deep tracts, and shows that operations can be conducted there in an environmental responsible manner.

The environmental impact of offshore platforms would be reduced if only those tracts shallower than 200 meters were offered. This derives directly from the fact that fewer platforms would be erected as a result of this sale, a situation similar to that previously discussed concerning the deletion of all oil or oil and gas prone tracts.

In any case, the potential environmental impacts of oil spills and platforms as discussed in Section IV of this statement apply to this alternative (of deleting all tracts deeper than 200 meters) as a diminution in risk of oil pollution events (from those deep water tracts that are oil or oil and gas prone) and a diminution of the cumulative impact of development of all these tracts.

Tracts could be deleted which are identified by matrix analysis to have the highest potential for environmental degradation of natural resources. Most of the tracts (except for a few that are far from shore in lightly fished areas, see Section IV.M.3.) that are oil or oil and gas prone are identified as having moderate or high risk potential for environmental damage. A total of 39 tracts are tentatively considered at this time to have high environmental risk potential as defined in this impact statement. Of those tracts that are considered to have moderate environmental risk potential some are relatively higher than others principally due to closer proximity to specific resource areas and use conflicts.

The tracts tentatively identified as highly hazardous and any specific number of the moderately hazardous tracts could be eliminated from the sale and this would correspondingly reduce the overall potential environmental impact of the proposed sale. Elimination of any tracts, however, would result in the loss from this sale of estimated recoverable reserves of oil and gas which would have to be made up from some other source.

Tracts identified as having unstable bottom sediments could be deleted. This would involve the deletion of 15 tracts which have been identified in the matrix analysis as highly hazardous. This would eliminate the risk of damage to a rig, an oil spill, or loss of life that might possibly occur due to this particular geologic hazard. This deleting as mentioned above, would also involve the loss from this sale of the potential reserves which would have to be made up from other sources.

b. Substitute Tracts

Tracts with relatively lower potential environmental risk could be substituted for those of higher potential risk. Such action would not necessarily result in less total activity or environmental effect since more acreage and blocks would be required to meet minimum resource estimates. This would result in more exploratory drilling, more platforms constructed, additional miles of pipelines required and a substantial increase in production activities with attendant increase in potential adverse environmental impacts discussed in detail throughout this environmental statement for these activities.

In all probability potential environmental benefits of substituting tracts with lower environmental risk and lower resource estimates may not be realized due to increased acreage and exploratory activity required.

B. <u>Withdraw the Sale</u>

In addition to modification of the proposed sale, all tracts could be withdrawn from leasing consideration. A decision to withdraw the sale completely or to seriously limit the number of tracts to be leased would diminish the contribution of OCS gas and oil toward meeting future energy demand, and would subsequently necessitate development of alternative sources of energy, with their associated environmental impacts. These impacts can be found in the assessment of possible short-term alternatives on the following pages.

The production from tracts projected for leasing at this sale would contribute significantly to meeting domestic energy needs in the short run (5 to 15 years). Research on alternatives for the long term is being accelerated. FY 74 and FY 75 funding for research and development is shown in a later section.

The following is a list of energy sources or actions which might be considered as short term alternatives to offshore oil and gas:

1. Energy conservation
2. Conventional oil and gas supplies
3. Coal
4. Synthetic sources of oil and gas
5. Hydroelectric power
6. Nuclear power
7. Energy imports

8. Other energy sources

9. Combination of alternatives

Discussion of each short term alternative includes a brief general description and then factors related to the contribution the alternative could make if the proposed sale were not held. A more detailed and comprehensive discussion of these energy sources, long term sources, and energy conservation may be found in _Energy Alternatives and Their Related Environmental Impacts,_ 1/ which reviews technology, state of development, resource base, supply and demand, costs and prices, and environmental impacts of each source.

Limitations on the substitutability of alternatives for OCS oil and gas include technology, high development and production costs, and time lag before the alternative could be a viable technical option. In early stages of development of an alternative source of energy, it may serve more as a supplement than as a substitute. Furthermore, there are some cases in which substitutability is diminished because of the projected use of the offshore oil and gas.

The discussion of these alternatives as presented below includes a consideration of the possibility of energy conservation as a method which might decrease or eliminate some of the energy requirements

---

1/ U.S. Department of Interior, Bureau of Land Management, Dec. 1973.

to be satisfied by this sale. The following table shows the equivalents which will be used in this discussion. When production has stabilized, the proposed Louisiana sale No. 36 may yield 70 to 125 thousand barrels a day of oil and 1 to 2.2 billion cubic feet a day of natural gas. Using common conversion factors, this level of production is first expressed in Btu's and then in terms of other important energy sources. The electrical equivalents were determined by considering two cases. The maximum requirement for generating capacity would result when the substitution of electrical energy for oil and gas occurred at the end use point. The minimum case is the result of substituting electrical energy produced by an alternative source for the electrical energy produced by OCS oil and gas.

Energy Needed From Other Sources to Replace The Expected
Oil And Gas Production From The Proposed Louisiana OCS Sale #36

1. Btu Equivalents 1/ in billions of Btu's per day

Oil -	70,000 to 125,000 bbl/day	406		725 billion Btu/day
Gas -	1 to 2.2 bil. cu. ft./day	= 1032	to	2270
Total		1438		2995

2. Oil Equivalents in barrels per day

Oil from other sources needed to directly replace expected oil production from Louisiana sale #36	70,000	to	125,000 bbl/day
Oil from other sources needed to replace expected gas production from Louisiana sale #36	178,000	to	391,000
Total	248,000	to	516,000

1/ Conversion factors used:
1 barrel of oil = 5.8×10^6 Btu
1 cubic foot of natural gas = 1,032 Btu
1 ton of coal = 24×10^6 Btu
1 kilowatt hour = 3,412 Btu at the theoretical conversion rate of other energy forms to electricity at 100% efficiency.

3. Gas Equivalents in billions of cu. ft. per day

Gas from other sources needed to replace expected oil production from Louisiana sale #36	0.4	to	0.7 bcf/day
Gas from other sources needed to directly replace expected gas production from Louisiana sale #36	1.0	to	2.2
Total	1.4		2.9

4. Coal Equivalent in thousands of short tons per day

Coal	60	to	125 thousand short tons/day

5. Electrical Equivalents in thousands of megawatts of capacity

Substitute for end uses 1/	14.3	to	29.7 thousand Mw
Substitute as input to electricity generation 2/	8.8	to	18.3 thousand Mw

1/ Based on a 65% average efficiency of end use of oil and gas (such as oil and gas heating) and a plant load factor of 80%.

2/ Efficiency of fossil fuel electricity generation was assumed to be 40%.

1. Energy Conservation

The shortage of oil and natural gas in the past few years has been reflected in curtailment of deliveries under existing contracts, inability to secure immediate and assured long term supplies, and denial of service to existing and prospective customers. The recent Middle Eastern oil embargo futher reduced supply.

Any tradeoff between energy conservation and development of OCS resources must recognize several factors: the widening gap between supply and demand for energy from all sources in the near future, the immediate shortage of natural gas and the need for oil to accomodate some of the unfulfilled demand for gas, and the limitations from the point of view of technology, cost and time lag on substitution of other energy sources for oil and gas. The shortfall in present and projected energy supply greatly exceeds the estimated production from the proposed sale. Energy conservation measures and development of the OCS both have an important role in reducing U.S. dependence on imported energy.

2. Conventional Oil and Gas Supplies

Large reserves of oil and gas still remain in the U.S. The U.S. Geological Survey estimates that undiscovered recoverable reserves — onshore are 135 to 270 billion barrels of oil and 605 to 1210

trillion cubic feet of natural gas. 1/ Improving technology and rising prices will enable development of previously uneconomical deposits and use of secondary and tertiary recovery techniques. However, discovery of the remaining reserves will be more difficult and expensive since larger structures have been studied extensively and the remaining reserves and harder to find.

To directly substitute for the proposed sale, onshore oil production would have to increase by 70,000 to 125,000 barrels a day and onshore gas production by 1 to 2.2 billion cubic feet a day. The mix of oil and gas that would provide the same Btu value as the estimated sale production ranges from all oil, 248 to 516 thousand barrels a day, to all gas, 1.4 to 2.9 billion cubic feet a day.

Economic incentives such as a rise in prices would be required to stimulate exploration and development in order to increase onshore production. Although prices of oil and gas have increased rapidly in the last year, it will be some time for price increases to be reflected in significantly expanded supplies of oil and gas. It is difficult to predict when and at what level oil and gas prices will stabilize. Current low exploration and discovery rates and declines in reserve levels must be reversed before production can begin to increase.

1/ Estimates calculated by the Geological Survey.

Alaskan North slope oil is not expected to increase supplies available to PAD Districts I-IV, which would receive almost all of the oil and gas from the proposed sale. Within the first few years of operation of the Trans-Alaskan Pipeline, all of the North slope oil would go to the West Coast (PAD V).

The environmental impacts of onshore oil and gas development may include land subsidence; soil sterilization due to oil, brines, and waste material released in blowouts, equipment failure, human error; disturbance of land by building road and structures; and pollution of ground and surface water due to poor well construction and spills. Impacts on air quality are usually minor and local.

Deregulation of the Wellhead Price of Natural Gas

The Federal Power Commission regulates the wellhead price of natural gas which goes into interstate commerce. It has been argued that prices established by the FPC have been too low, and have stimulated demand but discouraged exploration and development. Deregulation of the price of natural gas would allow prices to rise and thus stimulate exploration and production. However, in order for higher prices to result in higher proved reserves and production, promising prospects must be available. The OCS is one of the most promising areas for oil and gas development.

Nuclear Stimulation of Gas Formations.

Nuclear stimulation, an experimental method of fracturing low permeability gas reservoirs otherwise incapable of sustaining commercial production, has potential to add materially to U.S. recoverable gas reserves. The Atomic Energy Commission is conducting research and development of nuclear explosives and techniques for utilizing the effects of multiple nuclear explosives to recover natural gas locked in tight geologic formations. Such gas cannot now be produced economically by conventional methods. Most reserves which are amendable to nuclear stimulation lie in thick, deep reservoirs of very low natural permeability located in the Rocky Mountain area.

The Federal Power Commission has estimated that total yearly gas production by 1985 from the Uinta, Piceance, and Green River Basin fields using nuclear stimulation from 110 to 200 wells would be 812 to 1,939 billion cubic feet. 1/

Environmental effects of nuclear stimulation to increase natural gas production from tight reservoirs are related to radioactivity and seismic disturbance, both of which concern the surface or subsurface, leaving atmospheric contamination or disturbance unlikely. The depth of the gas formations of interest throughout the Rocky Mountain area is such that the probability of releasing any appreciable amounts of

1/ Federal Power Commission, April 1973, Natural Gas Technology Task Force for the Technical Advisory Committee of the Nautral Gas Survey by the Federal Power Commission, p. II-7.

radiation to the atmosphere at detonation time is considered negligible. Most of the radioactivity produced by the explosives will remain underground, trapped in the resolified rock near the bottom of the chimney or attached to the rock surfaces in the chimney,

Project design would consider mobile waters and assure that chimneys remain isolated from them. Methods are being developed to dispose of water produced with the gas and containing low levels of tritium.

The potential environmental impacts of nuclear stimulation of a single well or several wells in small geographic areas have been evaluated by the AEC for example, for the Rio Blanco and Wagon Wheel Projects. Extrapolation to more extensive development relates to frequency and size of explosives and changes in the local environment. The possibility that residual stress from a number of detonations might accumulate and present an earthquake stimulation hazard requires continued appraisal during future nuclear stimulation projects.

3. Coal

Coal is the most abundant mineral in the U.S. It has been mined in the eastern U.S. since the late 18th century, but emphasis is changing and the vast coal deposits of the Rocky Mountain region are growing in importance. The development of sulfur removal technology will play an increasing important role in the ability of coal industry to conform to government environmental, health, and safety regulations. About 46% of estimated remaining U.S. coal reserves contain 0.7 percent or less sulfur. Of this low sulfur coal, 93 percent is located west of the Mississippi.

Coal is mined in the U.S. by two primary methods: strip mining, also called surface or open pit mining, and underground mining. The mining method used depends largely on the amount of overburden overlying the coal seam.

To replace the expected energy from the proposed Louisiana OCS #36 sale (1.438 to 2.995 trillion Btu/day) with energy from coal would require the utilization of 22 to 46 million tons of coal per year. An increase of this magnitude could be supported by existing U.S. proved reserves. The primary constraints would be economic and environmental.

If this increased coal were provided by surface mining, it is believed that 4-9 mines of five million short tons annual capacity would be needed. One mine of this size would employ about 600 persons and have a capital cost of $40 million. To supply the necessary incremental amount would require 2,400 to 5,400 employees and capital expenditures of $160-360 million.

If underground mines were used, 11-23 mines of 2 million tons annual capacity would be required. Manpower for these operations would be 18,500 to 38,700 and capital expenditures would range from $253 to $529 million.

If the energy for this sale came from surface mined coal, the major consideration would be the amount of land disrupted. The following table gives an indication of how much land would be disturbed in the surface mining of 40 million tons/year.

Land Disturbed In Surface Mining Production

(Figures Based On 40 Million Tons Produced Annually)

Coal Bed Thickness (feet)	Recovery Factor (%)	Coal Available (million Per Sq. Mile tons)	Area Disturbed Annually (Sq. Mi.
10	80	9.216	4.3
15	80	13.824	2.9
20	80	18.432	2.2
25	80	23.040	1.7
30	80	27.648	1.4
35	80	32.256	1.2
40	80	36.064	1.1
45	80	41.472	1.0
50	80	46.080	0.9

The primary environmental impacts of coal begin with coal mining. Underground mining may cause land subsidence. Strip mining and open pit mining disrupt large surface areas, causing destruction of the top soil, wildlife habitats, vegetation. Large volumes of mine wastes must be disposed of. Water quality problems may arise from damage to the ground water regime, acid mine drainage, and increased runoff and sediment loads in streams. Stripping increases the dust in the air. Combustion of coal, especially high sulfur coal, releases particulate and gaseous pollutants. Technology to control the pollutants is not completely developed.

4. Synthetic Sources of Oil and Gas

Oil Shale

The U.S. has abundant oil shale resources that have not been developed in the past because of availability of oil and gas from conventional sources at lower development costs. The major options for oil shale development are (1) mining followed by surface processing of the oil shale and shale-oil, and (2) in-situ (in place) processing. Oil shale can be mined either at the surface or underground.

The richest oil shale deposits in the U.S. are found in the Green River Formation in Colorado, Wyoming, and Utah. This region is sparsely settled and arid or semi-arid.

Limitations on the rate of development of oil shale include availability of operating personnel, environmental restrictions, lack of supporting commerce and industry, and construction logistics.

From 1944 to 1956, the U.S. Department of the Interior conducted extensive research on the mining and retorting of oil shale and refining of shale oil. For the past ten years, private industry has operated prototype plants and experimental facilities. As yet, there has been no commercial production of oil from oil shale.

An estimated 73% of oil shale lands, containing nearly 80% of the Green River Formation reserves, are federally held. The U.S. Department of the Interior, which manages these Federal lands, has initiated a prototype oil shale leasing program to make these rich deposits available for development by private industry.

Under this alternative the expected oil and gas from the Louisiana OCS sale #36 would have to be replaced by 248,000 to 516,000 barrels a day of oil produced from oil shale. Since the oil shale industry in the U.S. is in its earliest stages, it is difficult to predict the magnitude of impacts associated with a given level of production. The Department of Interior, in its Final Environmental Statement for the Prototype Oil Shale Leasing Program, estimated the impacts for the Green River Formation region.

Their estimates are based on a "unit tract" with a production level of 50,000 barrels daily for underground mines and 100,000 barrels daily for surface mines. Using these estimates, land requirement projections are given below for production of 400,000 barrels a day.

Surface Mining	Land required, acres
Mine development	120 to 340 yearly
Permanent Disposal, overburden	4,000 total
Temporary Storage, low grade shale	400 to 800 total
Permanent Disposal, processed shale	560 to 600 yearly
Surface facilities	800 total
Off-site requirements	720 to 2,400 total
Underground Mining	
Mine development	80 total
Permanent disposal*	220 to 600 yearly
Surface facilities	1120 total
Off-site requirements	1440 to 1800 total

*Upper estimate is for surface disposal of all processed shale. Lower estimate is for underground return of 60% of processed shale.

The level of production needed to replace the proposed sale, 248,000 to 516,000 barrels daily, is considerably more than the projected development of the oil shale industry. The National Petroleum Council estimates production to be 150,000 barrels a day by 1980 in the most optimistic case. The Interior Department has projected that oil shale production by this date could reach 400,000 bbls./day. Even under the most optimistic conditions, production of shale oil is not expected to exceed 750 thousand b/d in 1985, 1/ assuming that syncrude "prices" are adequate to encourage commercial development. A spokesman for Colony Development, one of the companies with the most experience in oil shale, estimated that commercial oil shale production will not exceed 500,000 b/d by 1985. 2/

Development of feasible and economic in situ methods is important for eventual recovery of deeply buried oil shale resources in the Green River Formation. The technology of in situ (in place) retorting is less advanced than that of conventional processing (surface or underground mining, crushing, and above ground retorting).

1/ National Petroleum Council, U.S. Energy Outlook, Dec. 1972, p. 205.

2/ Platt's Oilgram, Dec. 3, 1973, Vol. 51, No 232, p. 1. statement by John Hutchins, V.P. of Cameron Engineers and Manager of Colony Shale Oil Plant. Testimony to the House Interior Mining subcomittee, Nov. 30, 1973.

Problems have included insufficient naturally occurring permeability, or failure to artifically induce permeability in order to permit heat transfer and passage of gases and liquids, and inability to remotely control the process with sufficient accuracy through well-bores from the surface. Additional problems if nuclear explosives are used are possible ground motion and release of radioactivity.

Environmental problems related to the extraction of shale oil by conventional (as opposed to *in situ*) retorting are magnified by the large volume of rock that would be processed in a commercial operation. A plant producing 100,000 b/d would probably mine about 130,000 tons of shale oil per day and would require disposal of a similar amount of spent shale. Surface disposal of the spent shale creates the problem of revegetation. Other problems are prevention of contamination of streams by saline water encountered in mining or by leaching of salts from spent shale.

The Green River Formation area is sparsely settled and arid or semi-arid. Development of an oil shale industry would change existing land use patterns and create a major socio-economic impact in a region now without large scale industry. It would also disturb regional wildlife. The Colorado oil shale lands have some of the largest migratory deer and elk herds in the world.

Roads, mining plant sites, waste disposal areas and utility and pipeline corridors would disturb the vegetative cover of the land and increase sediment loads in streams. The requirement of large amounts of waste water and the disposal of waste water with dissolved saline and organic compounds without degrading natural ground waters would place added stress on the scarce water resources of the region. Increased noise and a decline in air quality due to dust from mining and shale disposal and particulate and sulfur and nitrogen oxide emissions would accompany oil shale development.

Synthetic Natural Gas and Oil

Processes to convert coal and other feedstocks to various hydrocarbon liquid and gaseous substitutes for oil and natural gas have not yet reached commercial production in the U.S. although several commercial plants in western Europe use the Lurgi coal gasification process to produce low-Btu value gas. To date, more research effort has gone into development of coal gasification processes than into coal liquefaction, partly because of the availability of imported oil at lower cost than synthetic crudes. Natural gas can also be synthesized from petroleum. Such gas has been produced commercially in Europe and some forty plants are in the planning stage for the U.S. Feedstocks used range from naptha and other lighter hydrocarbons to crude oil. Oil gasification does not add to overall energy supplies

but can increase short-term gas supply. However, the availability of light hydrocarbons and refinery capacity to produce feedstocks for these plants is questionable.

The main barriers to synthetic gas and oil development have been economics and technology. Most processes have not yet advanced beyond the pilot plant stage, have not been tested commercially, and have not been able to compete in cost with other energy sources. This situation is changing. Factors that will influence the development of coal gasification include availability of coal, environmental constraints on coal production and SNG production, capital availability, health and safely considerations in coal mining, and availability of water.

A typical coal gasification plant will produce 250 million cf/d of pipeline quality gas per day, consume 6 to 10 million tons of coal yearly, use about 6,000 gallons of water per minute, and have capital costs of over $400 million, including the development of the coal mine. 1/

1/ Talk given at a coal seminar, August 21, 1973 at Price, Utah by Dr. Thomas A. Henrie, Bureau of Mines, Deputy Director, Mineral Resources and Environmental Development.

This alternative would involve a combination of synthetic oil and gas with a total value of 1.438 to 2.995 trillion Btu's, the energy equivalent of the oil and gas expected from the proposed Louisiana OCS #36 sale. The mix could range from all synthetic oil, 248,000 to 516,000 barrels a day (89.3 to 185.8 million barrels a year) to all synthetic gas, 1.4 to 2.9 billion cf a day (.50 to 1.04 trillion cf a year).

Complete substitution by coal gasification would require 6 to 12 250 billion Btu's per day coal gasification plants, 30 to 60 million tons of coal per year, and 10 to 20 coal mines. At an estimated $250 million for each plant, these plants would cost $1.5 to $3.0 billion. Because of the present lack of a commercial synthetic gas industry and the uncertainty of the related economics and technology, SNG production projections are uncertain. Synthetic natural gas production does not add to overall energy supplies. Rather, it increases gas supply by converting other more abundant and less environmentally acceptable fuels to gas, providing flexibility of energy supplies.

The first environmental obstacle to coal gasification and liquefaction is coal retrieval. In addition, these processes must contend with water consumption and contamination, air pollution from sulfur

components and particulate matter, and possible noise and site pollution. Impacts on air quality stem from sulfur oxides, hydrogen sulfide, nitrogen oxide, ash, and ammonia. Technology to control these emissions is still under development.

5. Hydroelectric power

Conventional hydroelectric developments convert the energy of natural regulated stream flows falling from a height to produce electric power. Pumped storage projects generate electric power by releasing water from an upper to a lower storage pool and then pumping the water back to the upper pool for repeated use. A pumped storage project consumes more energy than it generates but converts off-peak, low value energy to high-value peak energy.

Most available sites for economical production of conventional hydroelectric power have been developed. The Pacific region has the greatest total conventional hydroelectric potential, and leads the other States in both developed and undeveloped capacity. Alaska has the second highest potential, although less than one percent is developed. In many parts of the country there are numerous physical opportunities for developing pumped storage projects but only a limited number have been investigated. Pumped storage is expected to account for a large part of projected additions to hydroelectric capacity in the next few decades.

Hydropower projects have multipurpose benefits, such as recreation, water supply, fish and wildlife enchancement, and flood control. These benefits may justify projects that would otherwise be uneconomic for a single purpose. Initial capital costs of hydropower projects vary greatly depending on location, size, and design. Operating expenses are low compared to other alternatives.

The hydroelectric generating capacity required to substitute for the energy from the oil and gas expected from the proposed Louisiana OCS #36 sale depends on whether the oil and gas is employed in direct end uses (such as oil and gas heating) or in electricity generation. Since direct uses convert oil and gas to energy more efficiently, a larger generating capacity would be required to substitute for this energy.

To substitute for end uses, capacity of 14 to 30 thousand megawatts would be needed. To substitute for the electricity which could be generated by the oil and gas, 9 to 18 thousand megawatts of capacity would be needed.

The extent of U.S. conventional hydropower potential east of the Mountain states, the region to be served by the proposed Louisiana OCS #36 sale, is shown below.

Region	Potential Power	Developed Capacity	Undeveloped Capacity
New England	4.8	1.5	3.3
Middle Atlantic	8.6	4.3	4.3
East North Central	2.2	0.9	1.3
East South Central	9.1	5.2	3.9
West North Central	7.0	2.7	4.3
South Atlantic	14.5	5.5	9.0
West South Central	5.1	2.1	3.0
Total	51.3	22.2	29.1

All units are thousands of megawatts.
Source: From "Hydroelectric Power Resources of the United States, Developed Undeveloped, January 1, 1973," Federal Power Commission, December, 1972.

The feasibility of hydropower as an alternative to the oil and gas expected from the Louisiana #36 sale is restricted by several factors. Hydroelectric power cannot be substituted for use of oil and gas in transportation and in industrial processes dependent on unique properties of oil and gas. Land use considerations may preclude development of the few promising potential conventional hydro sites east of the Mountain states. Sites where pumped storage projects may be developed are numerous but have not been systematically inventoried. Furthermore, few dams are built solely for hydroelectric power generation. Irrigation, navigation, municipal and industrial uses, and flood control are frequently more important than and not fully compatible with power production needs. Since hydropower is most often used to service peak loads, other energy sources must be relied on for base power loads.

Construction of a hydroelectric dam represents an irretrievable commitment of the land resources beneath the dam and lake. Inundation of the land eliminates wildlife habitat and precludes other uses such as agriculture, mining, and free-flowing river recreation. Some increase in erosion during construction and operation will occur.

Hydroelectric projects use a renewable resource and do not cause air pollution. On the other hand, use of streams for power may displace recreational and other uses. Water released from reservoirs during summer months may change the water temperature and lower the oxygen content of the river downstream, adversely affecting the fishery. Fluctuating flow releases for peak load operation may also adversely affect fisheries and downstream recreation. The lack of satisfactory means of passing anadromous fish over high dams precludes development of some favorable hydroelectric sites.

Fish may die from gas-bubble disease if exposed to nitrogen supersaturated water. Nitrogen supersaturation results at a dam when excess river flow must be passed over the spillway. High nitrogen levels in the Columbia and Snake Rivers pose a threat to the salmon and steelhead resources of these rivers. The Corps of Engineers is studying this problem.

6. Nuclear Power

The development of nuclear energy represents an important advance in the electric power industry. The predominant nuclear system used in the U.S. is the uranium dioxide fueled, light water moderated and cooled nuclear power plant. Research and development is being directed toward other types of reactors, notably the breeder reactor and fusion reactors.

Installed nuclear capacity is now 25,000 MW. At the end of 1973, nuclear power generated about 5 percent of the Nation's electricity. However, about half of the electric power capacity under construction is nuclear powered. Nuclear power has been set back by delays in licensing and siting, environmental constraints, manufacturing and technical problems, and regulatory difficulties. Future capacity will be influenced by the availability of plant sites, plant licensing considerations, environmental factors, nuclear fuel costs, rate of development of the breeder and fusion reactor, capital costs. In order to meet future uranium requirements, an immediate increase in exploratory drilling activity will be required.

We have calculated the nuclear capacity required to generate electricity to substitute for OCS sale production for two cases:

(1) all of the OCS oil and gas were used to generate electricity

(2) all of the OCS oil and gas were devoted directly to end uses such as oil and gas heating.

Nuclear capacity required to substitute for the electricity which could be generated by the projected oil and gas from sale #36 would be 9 to 18 1000-MW plants.

Capacity required to substitute for end uses would be 14 to 30 1,000-MW plants. Associated parameters are shown for both cases, assuming model 1000-MW light water reactors.

	9 to 18 1,000-MW Light Water Reactors	14 to 30 1,000-MW Light Water Reactors
a. tons U_3O_8 first core fuels - first year only 1/	5,220-10,440	8,120-17,400
b. thousands of tons of uranium ore required for a 2/	2,610-5,220	4,060-8,700
c. tons U_3O_8 annual reloads without plutonium recycling	1,800-3,600	2,800-6,000

1/ Assuming 80 percent plant factor.

2/ Assuming 0.20 percent average ore grade.

	9 to 18 1,000-MW Light Water Reactors	14 to 30 1,000-MW Light Water Reactors
d. thousands of tons of uranium ore required for c	900-1,800	1,400-3,000
e. tons U_3O_8 annual reload with plutonium recycling	1,575-3,150	2,450-5,250
f. thousands of tons of uranium ore required for e	740-1,575	1,225-2,625
g. acres of land required for sites 3/	15,000-30,000	23,500-50,000
h. thousands of gallons of radioactive wastes produced yearly	81-162	126-270

3/ Assuming an average of 1,500 acres per 1,000- MW unit for cooling ponds and 500 acres per site containing three 1,000-MW units.

Although nuclear plants do not emit particulates or gaseous pollutants from combustion, several unique environmental problems arise. Some radioactivity in the form of radiation, airborne radioactivity, and radioactive liquids, is released to the environment. Although the amount released is very small and potential exposure has been shown to be less than the average level of natural radiation exposure, special precautions are required to control these emissions. The possible release of radioactivity as a result of an accident must be anticipated in the design of the plant and its emergency systems. Malfunction of the emergency core cooling system has been of particular concern.

Nuclear plants use essentially the same cooling process as fossil-fuel plants and thus share the problem of heat dissipation from cooling water. However, light-water reactors require larger amounts of cooling water and discharge greater amounts of waste heat to the water than comparably sized fossil-fuel plants. The effects of thermal discharges may be beneficial in some cases. Adverse effects can be mitigated by use of cooling ponds or cooling towers.

Low level radioactive wastes from normal operation of a nuclear plant must be collected, placed in protective containers, and shipped to an AEC storage site and buried. High level wastes created within the fuel elements remain there until the fuel is spent. They are then isolated in a fuel reprocessing plant and stored in liquid or solid form at AEC facilities.

7. Energy Imports

Oil Imports

U.S. reliance on imported oil has increased steadily in the last decade. Competition on the world market and cutbacks in Middle Eastern oil exports have raised questions about availability of oil imports in the future. Declining resource availability and increasing domestic demand restrict potential imports from the Western Hemisphere, particularly Latin America. Increasing imports from the Middle East bring problems of security of supply, balance of payments, U.S. off loading terminal capacity, and refinery capacity.

To replace the oil and gas from the proposed sale would require oil imports of 248,000 to 516,000 barrels a day (89 to 186 million barrels a year). If 29,000 DWT tankers were used (the average size tanker calling at U.S. ports in 1972), there would be about one to three additional tanker unloading each day. If 60,000 DWT tankers were used, about one additional tanker would have to be unloaded every day.

Importing petroleum would have a negative impact on the United States balance of payments. Some of the factors affecting this impact are: the type of import, i e., crude oil, semi-refined products, or refined products; the price of imported oil; the exporting countries' propensity to import from the U.S.; the amount of U.S. capital invested

in the exporting country for production, transportation and terminal facilities, and the amount of U.S. goods and services used in the exporting country for these facilities; and the nationality of vessels carrying the oil. In the past, imported petroleum was generally less expensive than domestically produced petroleum. Recently, the price of foreign oil delivered to the U.S. has risen to a level equal to or greater than that of oil produced on the OCS.

The primary environmental hazard of increased oil imports is the possibility of oil spills. Spills can result from intentional discharge, accidental discharge, and tanker casualties. Intentional discharges would result largely from tank cleaning operations, which in 1969 to 1970 had an overall discharge rate of 0.074 percent of cargo. At this rate, import levels of 248,000 to 516,000 barrels a day would result in discharges of 184 to 382 barrels a day. In 1970 approximately 0.0015 percent of oil handled in the U.S. was accidentally released during transfer operations. At this rate, 4 to 8 barrels a day would be accidentally spilled. The worldwide tanker casualty analysis indicates that, overall, an insignificant amount of the total volume of transported oil is spilled due to tanker accidents. However, a single incident such as the breakup of the Torrey Canyon can have disastrous results. With increasing tanker traffic in already crowded harbors, the probability of such an incident is increased.

Energy Imports

Natural Gas

Pipeline imports of natural gas into the U.S. have come mainly from Canada and Mexico. However, significant expansion of natural gas imports from these countries is questionable because of increasing domestic demand, both current and future, within Canada and Mexico. If new Canadian discoveries result in large reserve additions, major surpluses may become available for export to the U.S.

The growing shortage of domestic gas has encouraged projects to import liquefied natural gas (LNG) under long term contract. Large scale shipping of LNG is a relatively new industry and the U.S. does not yet have facilities for receiving base load shipments. Several LNG projects are now under consideration on the Pacific, Atlantic, and Gulf coasts. However, the Middle East oil cutback has raised questions concerning the security of foreign, especially Algerian, sources of LNG. The complexity of and length of time involved in implementing these proposals has been increased by the need for negotiating preliminary contracts, securing the approval of the Federal Power Commission and the exporting country, and making adequate provision for environmental and safety concerns in the proposed U.S. facilities.

Natural gas imports of 1.4 to 2.9 billion cubic feet a day (504 to 1044 billion cubic feet a year) would be required to replace the total energy expected from the sale. The chief source of possible increased pipeline natural gas imports is Canada. The Canadian policy has been to restrict the level of natural gas exports in order to build a large domestic reserve. Unless this policy changes or significant new Canadian discoveries are made, it is unlikely that more gas would be available to import.

LNG import levels will depend on how soon this industry can be introduced into the U.S. The question of security of foreign LNG supplies has caused re-evaluation of these projects. To supply the energy expected from the proposed sale with LNG imports would require unloading one 125,000 cubic meter tanker every day to every other day and the construction of four to eight 350 million cubic feet a day regasification plants.

The environmental impacts of LNG imports arise from tankers; terminal, transfer, and regasification facilities; and transportation of the gas. The primary hazard of handling LNG is the possibility of a fire or explosion during transportation, transfer, or storage.

Receiving and regasification facilities will require prime shoreline locations and dredging of channels. Regasification of LNG will release few pollutants to the air or water.

LMG imports will influence the U.S. balance of payments. This impact will depend on the origin and purchase price of the LNG, the source of the capital, and the country (U.S. or foreign) in which equipment is purchased and LNG tankers are built.

8. Other Energy Sources

The basic nature and occurrence of any energy source largely govern the technological opportunities and problems involved in its application. As research continues probing into the nature of numerous energy sources, many potential alternatives to conventional energy production are emerging. The existence of some of these sources has been known for decades, although unfavorable economics or incompletely developed technologies have hampered their commercial application. Long range projections must take into account such potential sources of energy, since a major technological breakthrough in any number of areas could realize a considerable change in the current energy picture.

Environmental impacts of these more exotic alternatives are difficult to assess, particularly where there is a great amount of research and development that must be done before operational scale systems can be developed, tested, and evaluated for production and application.

Lack of resources (due either to geographic location or lack of quantity and quality), underdeveloped technology, or lack of an economic advantage over conventional energy sources are the chief reasons these other sources are unlikely to have significant availability before 1985. Beolow are summarized the various energy forms considered here in relation to their primary and secondary limitations.

I. Possible significant energy contribution before 1985 1/

Energy forms	Primary limitations	Secondary limitations
Geothermal energy	Resources	Economics
Tar sands	Resources	Economics

II. Improbable significant contributions before 1985

Energy forms	Primary limitations	Secondary limitations
Hydrogen	Economics	Technology
Biological (agricultural & wastes)	Economics	Resources
Solar	Technology	Economics
Tidal	Resources	Economics
Wind	Resources	Economics
Energy Conversion Devices		
Fuel cells	Technology	Economics
Thermionics	Technology	Economics
Thermoelectric	Technology	Economics
Magnetohydrodynamics	Technology	Economics

1/ After: New Energy Forms Task Group 1971-1985, National Petroleum Council Committee on U.S. Energy Outlook, 1972.

Federal energy research and development funding has expanded significantly in the last few years. President Nixon announced in his Energy Message of January 23, 1974, that Federal commitment for direct energy research and development will be increased to $1.8 billion in FY 75. The table below shows the funds for different areas of research and the agencies involved.

Federal Energy R&D Funding
($ million)

Direct programs	FY74	FY75	Agency*
Conservation	65.0	128.6	
a. End use (residential & commercial)	15.0	27.9	DOI, other
b. Improved efficiency (transmission)	5.0	18.8	AEC,DOI, NSF
c. Improved efficiency (conversion)	14.9	29.8	AEC,DOI,NSF
d. Improved efficiency (storage)	2.9	6.4	AEC,NSF
e. Automotive	14.2	23.7	AEC,EPA,NSF,DOT, DOD,NASA
f. Other transportation	13.0	22.0	DOT,DOC
Oil, gas, and shale	19.1	41.8	
a. Production	3.0	17.0	DOI
b. Resource assessment	5.0	13.1	DOI,NSF
c. Oil shale	2.3	3.0	DOI
d. Related programs	8.8	8.7	AEC,DOI
Coal	164.4	415.5	
a. Mining	7.5	55.0	DOI
b. Mining, health, & safely	27.0	27.7	DOI
c. Direct combustion	15.9	36.2	DOI,NSF
d. Liquefaction	45.5	108.5	DOI,NSF
e. Gasification (high BTU)**	33.0	65.3	DOI,NSF,AEC
f. Gasification (low BTU)	21.3	50.7	DOI,NSF
g. Synthetic fuels pioneer prog.		42.1	DOI
h. Resource assessment	1.2	1.9	DOI
i. Other (incl. common technology)	11.7	28.1	DOI

Environmental control	65.5	178.5	
a. Near term SO_x	39.9	82.0	EPA, DOI
b. Advanced SO_x	4.0	12.0	EPA
c. Other fossil fuel pollutants (incl. NO_x, particulates)	13.1	57.0	EPA
d. Thermal pollution	1.5	18.5	EPA,AEC
e. Automotive emissions	7.0	9.0	EPA
Nuclear fission	530.5	724.7	AEC
a. LMFBR	357.3	473.4	
b. Other breeders (GCFBR & MSBR)	4.0	11.0	
c. HTGR	13.8	41.0	
d. LWBR	29.0	21.4	
e. Reactor safety research	48.6	61.2	
f. Waste management	6.2	11.5	
g. Uranium enrichment	57.5	66.0	
h. Resource assessment	3.4	10.4	
i. Other (incl. advanced tech.)	10.7	28.8	
Nuclear fusion	101.1	168.6	AEC
a. CTR	57.0	102.3	
b. Laser***	44.1	66.3	
Other	53.5	157.5	
a. Solar	13.8	50.0	AEC,NSF
b. Geothermal	10.9	44.7	AEC,DOI,NSF
c. Systems studies	17.3	30.0	AEC,DOI,NSF,FEO, Treasury, FPC, other
d. Misc.	11.5	32.8	NSF,DOI
Support programs			
Environmental effects research	169.7	303.4	AEC,EPA,NSF
a. Pollutant characterization, measurement, & monitoring	16.3	37.4	
b. Transport of pollutants	26.6	55.6	
c. Health effects	72.6	112.5	
d. Ecological effects	27.3	65.0	
e. Social & welfare effects	17.5	19.8	
f. Environmental assessment & policy formulation	9.4	13.1	

Basic research	94.5	174.6	AEC, NSF
a. Materials	13.2	32.9	
b. Chemical, physical, engineering	30.8	58.1	
c. Biological	40.3	60.5	
d. Plasmas	2.8	8.2	
e. Mathematical	7.4	14.9	
Manpower development	6.3	8.5	AEC, NSF
Total (direct energy R&D)	999.1	1,815.5	
Total (support programs)	270.5	486.5	
Total (direct & support)	1,269.6	2,302.0	

*Agency codes:
- AEC - Atomic Energy Commission
- DOC - Department of Commerce
- DOD - Department of Defense
- DOI - Department of the Interior
- DOT - Department of Transportation
- EPA - Environmental Protection Agency
- FEO - Federal Energy Office
- FPC - Federal Power Commission
- NASA - National Aeronautics and Space Administration
- NSF - National Science Foundation

**Funds for high Btu gasification in the Office of Coal Research budget do not include Trust Fund amounts.

***Includes amounts for laser fusion directed toward military applications.

9. Combination of Alternatives

In the interest of clarity of presentation this analysis has discussed separately each potential alternative form of energy as a possible substitute to the oil and gas anticipated from the proposed sale. It is highly unlikely that there will ever be a single definitive choice to be made between any potential energy form and its alternatives. Each may have a role to play; some may make major contributions to our energy supplies, while others may be subordinated to lesser roles. Some alternatives may be developed rapidly; others may evolve more slowly, perhaps to make a more important contribution at a later date. Forecasting on the basis of present knowledge of the relative roles of these potential alternatives is a highly subjective exercise which must necessarily include a large measure ofjudgement as to future trends in such variables as the direction and pace of technological development, the identification of usable resources, the rate of national economic growth and changes in our life style.

It seems most probable that many alternatives will be developed to some degree. Understanding of the extent to which they may replace or complement offshore oil and gas requires reference to the characteristics of our total national energy system. Factors most relevant to the issues at hand are outlined below:

1. Historical relationships indicate that energy requirements will grow at approximately the same rate as gross national product.

2. Energy requirements can be constrained to some degree through the price mechanisms in a free market or by more direct constraints. One important type of direct constraint operating to reduce energy requirements is through the substitution of capital investment in lieu of energy; e.g., insulation to save fuel. Other potentials for lower energy use have more far-reaching impacts and may be long range in their implementation - they include rationing, altered transportation modes, and major changes in living conditions and life styles. Even severe constraints on energy use can be expected to only slow, not halt, the growth in energy requirements within the time frame of this statement.

3. Energy sources are not completely interchangeable. Solid fuels cannot be used directly in internal combustion engines for example. Fuel conversion potentials are severely limited in the short term although somewhat greater flexibility exists in the longer run and generally involves choices in energy-consuming capital goods.

   The principal competitive interface between fuels is in electric powerplants. Moreover, the full range of flexibility in energy use is limited by environmental considerations.

4. A broad spectrum of research and development is being directed to energy conversion - more efficient nuclear reactors, coal gasification and liquefaction, liquified natural gas (LNG), and shale retorting, among others. Several of these should assume important roles in supplying future energy requirements, though their future competitive relationship is not yet predictable.

5. Major potentials for filling the supply/demand imbalance for domestic resources are:
   - More efficient use of energy
   - Environmentally acceptable systems which will permit production and use of larger volumes of domestic coals.

- Accelerated exploration and development of all domestic oil and gas resources.
- Development of the Nation's oil shale resources.

Of the foregoing increased domestic oil and gas production offers considerable possibilities, although adequate incentives must exist for indicated and undiscovered domestic resources to be discovered and extracted.

6. The acceptability of oil and gas imports as an alternative is diminished by:
   - The security risks inherent in placing reliance for essential energy supplies on sources which have demonstrated themselves to be politically unstable and prone to use interruption of petroleum supplies to exert economic and political pressure on their customers.
   - The aggravation of unfavorable international trade and payments balances which would accompany substantial increases in oil and gas imports.
   - Apparent high costs of liquefying and transporting natural gas other than overland by pipeline.

C. Delay Sale

1. Until New Technology is Available to Provide Increased Environmental Protection

The sale could be delayed until new technology is available: however, basically safe technology is available provided its application and use are properly regulated and controlled. As new technology relating to safety and environmental protection is developed, it can be incorporated with existing requirements and applied to all OCS leases so that bringing on additional production now will not generally preclude adaptation of new advances to the prospective leases. "Zero risk" does not exist but is an idea toward which safety systems are directed. In the history of Federal offshore leasing and production over the past 19 years only 11 spills of 1,000 bbl. or more have occurred in more than approximately 1,500 leases, 10,500 drilling holes, and 1,939 producing platforms.

2. Pending Completion of Studies Concerning the Potential Environmental Impacts of Offshore Minerals Development in General and Oil Spills Specifically

The proposed sale could be delayed pending completion of all studies concerning the potential environmental impacts of offshore minerals development in general and oil spills specifically. Many long-term, ongoing studies relating to these issues are being conducted by the scientific community, industry, and government. The Bureau of Land Management is initiating long-term, ongoing studies of its own both on an inhouse and contract basis. See Section I.G. for a description of the Bureau's present study efforts relating to the OCS program.

A central feature of many of these studies is that they are never really completed in the sense that they rarely reach definitive conclusions with wide applicability, but simply advance from one stage to another, from one level of analysis to another, thereby contributing to a growing area of knowledge and body of literature pertaining to the numerous complexities of environmental analysis. To delay the sale on the basis of incompleted studies would require an indefinite delay perhaps of many years duration. As the recent University of Oklahoma study: "Energy Under the Oceans: A Technology Assessment of Outer Continental Shelf Oil and Gas Operations", points out, current and programmed research on OCS environmental data will help improve our knowledge, however, acquiring a total functional understanding of the coastal environmental is an "extremely long-term goal". Undoubtedly, information gaps and uncertainties will always be associated with offshore minerals development and any delays in such development programs must be judged on the basis of whether or not these gaps and uncertainties are so great, compared to what is known, as to warrant postponement. The OCS oil and gas leasing program will help make available increased supplies of energy resources of Federal lands for national energy needs. Final judgment must rest on a determination regarding whether or not a delay in this proposed lease sale would be in the Nation's best interest.

3. Pending Development of Land Use and Growth Plans Onshore

The proposed sale could be delayed pending the development of land use and growth plans onshore. Timetables for onshore development plans differ from state to state in terms of initial development of plans, updating, revisions, and subsequent implementation. Delay of the sale awaiting such plans could cause the development of the offshore mineral resources to occur in a piecemeal, unorderly manner. It could result in a greater degree of coordinated planning between states and the Federal Government especially with regard to coastal areas and would result in the avoidance of potential environmental impacts resulting from lack of coordinated efforts. It should be stated, however, that onshore development must take place within the authority of state and local agencies, and coordination with the jurisdictional agencies is sought throughout the entire leasing and development process.

4. Pending Completed Implementation of Recommendations Made in Reports on OCS Operating Orders and Regulations and a Review of Regulations and Amendment as Necessary

A decision could be made to delay this sale until the implementation of those recommendations made in reports concerning strengthening operating procedures discussed in Vol. I, Section I.G.2 had been completed. During the implementation of these recommendations, a review could be completed of all operating and leasing regulations, OCS orders, and statutory provisions to locate sections that needed revision. Any necessary amendments of the regulations and orders

could be made through the appropriate procedures and if sections of the OCS Act were found to need revision, amendments could be suggested to Congress. In considering this alternative, the existing authority of the OCS Act to prescribe and amend regulations at any time when the Secretary determines it to be necessary and proper so as to provide for the prevention of waste and conservation of the natural resources of the Outer Continental Shelf and the protection of correlative rights therein must be kept in mind. 43 U.S.C. § 1334(a)(1). Any revisions of the operating regulations or the OCS orders which relate to the prevention of waste, conservation of natural resources, or protection of correlative rights could be made at any time and apply to all existing leases. It is unlikely, however, that amendments to the OCS Act or regulations dealing with matters other than the above could be applied to leases in existence at the time of the amendment. If such amendments were felt necessary for leases which may be executed if the proposed sale takes place, they would have to be done before the leases were signed by the parties.

Environmental Impact of a Decision to Delay the Sale

A decision to delay the sale based upon any combination of the four reasons given above would eliminate any environmental impact to the offshore or onshore area of the sale during the period of the delay. The environment of the area would exist during the delay essentially as it does today. Assuming a decision was made to hold the sale at a future date after all the reasons for delay had been

satisfied, the environmental impact would reflect the degree of success achieved in attaining more fail-safe technology, baseline biological data against which the potential impacts could be assessed, land use development plans with which operations could be coordinated, and revised leasing and operating regulations and orders to strengthen the management of OCS operations and minimize the impact of such operations.

It is conceivable that the potential environmental impact of operations resulting from a sale held after such a delay would be of much the same character as those potential impacts discussed in this statement, but that the potential for such impacts occurring would be minimized. Some impacts might be reduced entirely if changes in operating techniques were the result of the review conducted during the delay period. For instance, biological baseline data and other research might suggest that drilling muds are harmful when released into the marine environment. If such findings were made, different operating procedures would no doubt result to eliminate or reduce this impact. Such different operating procedures would have their own environmental impact which would have to be considered.

If this sale were delayed for the reasons given, it is evident that the delay would be for more than just a few months. A delay of at least two years could reasonably be expected to complete baseline studies, develop improved technology, implement land use programs - particularly under the Coastal Zone Management Act, and implement

the recommendations and regulatory changes discussed above. In the event of a delay of that duration, alternative energy sources would be expected to fill the gap left in the needed energy supply during that period. These alternative energy sources have their own environmental impact as discussed earlier in this section of the statement. Depending upon the alternative source or combination of sources drawn upon to meet the demand left unsatisfied by the delay of this sale, the environmental impact to the Nation could be more or less than that anticipated from this sale.

Other than these general statements concerning the environmental impact of delaying this sale, it is difficult to determine the precise impacts should the sale be held at some later date. The changes that might be made in a later sale are speculative at this stage because of uncertainty of the type of baseline data that would have to be gathered, improvements in technology, and revised regulations that could result. It can be said with certainty, however, that prior to deciding to hold a sale at a later date, the environmental impact would be thoroughly assessed.

D. Government Exploratory Drilling Before Leasing

Another alternative to the present leasing system is Government exploratory drilling before holding lease sales. At the present time there is no exploratory drilling on the OCS prior to leasing. The U.S. Geological Survey receives all engineering and geological data from companies who have drilled on leases issued on the OCS. These data and geophysical data purchased on the open market are used by the Geological Survey to develop OCS lease policies and evaluate tracts prior to leasing.

Oil and gas companies spend millions of dollars acquiring geological and geophysical data, and on data processing and interpretations to enable them to compete in lease sales. In 1971, U.S. exploration expenditures were $2.4 billion, down from an historical peak of 3.4 billion in 1968. (This cost includes drilling and equipping exploratory wells, acquiring undeveloped acreage, lease rentals, geological and geophysical expenditures,test well contributions, land department costs including leasing and scouting, and other, including direct overhead.) 1/ The value of their information depends upon its exclusive and proprietary nature. Because of the high costs, companies generally combine in "group shoots" and share the expenses of seismic data acquisition or purchase data from geophysical service companies. A very few companies have their own equipment and do their own work

---

1/ "What It Costs to Find Hydrocarbons in the U.S.," World Oil (October 1973), p. 77.

under research and development departments. Geophysical service companies acquire data on specific areas on a speculative basis hoping to sell it to several companies. Therefore, although several companies and the Government may have the same data it is proprietary to the purchaser and cannot be revealed. Each purchaser believes his competitive edge in its use is his interpretation and application.

Government exploratory drilling would have several advantages. It could establish the existence, possible extent, and quality of oil and gas resources, and signal problems that may occur if development follows. The Government would be in a better position to take the initiative in selecting tracts to be included in a sale, evaluating resource potential, determining pre-sale estimated value, analyzing lease bids, and identifying environmental problems for the protection of sensitive areas through lease stipulations. At the present time, the oil and gas industry sometimes has more seismic data than the Government for some tracts and industry assists Government through the nomination process in the selection of specific tracts in a general area designated for leasing.

The availability of data from Government exploratory drilling would tend to eliminate the need for costly exploratory effort by industry and encourage companies to channel their efforts into the acquisition and development of producible leases. Availability of data from

exploratory drilling could encourage smaller companies to participate in leasing by greatly reducing capital outlays required to evaluate tracts and reducing the competitive advantage of a few companies which possess exclusive data. These tendencies would be counteracted to the extent that companies distrusted Government findings and continued to undertake independent exploration and data acquisition.

Also, large companies having the same data and more money could still outbid smaller companies. However, data from exploratory drilling would provide significantly better resource evaluation than any other method.

The cost to the Government of an adequate exploration program would be tremendous, whether the Government contracted out the work or purchased and operated the equipment itself, hired its own personnel, and did all of its own analysis. For example, consider drilling costs alone. To drill a typical offshore exploratory will cost about $2.1 million dollars. Of this, about 65% represents operating costs and 22% mobilization and demobilization. 1/ Each company evaluates in depth only the most promising tracts and those in which it has a particular interest. In contrast, a Government exploration program would require a detailed evaluation including seismic work and coring and exploratory drilling, of extensive OCS areas, not of just a few tracts. Under present practice, the cost of seismic data collection is lowered by being "speculative data" for sale to many companies.

1/ "Finance and Economics of Offshore Operations," World Oil (July 1973) p. 86.

A Government exploratory drilling program would result in the Government assuming the risks and costs now borne by companies. Much of the resources devoted to data acquisition and interpretation by private industry would be freed for development and production. Such a Government program would be tantamount to finding the oil for industry and leasing the reservoirs to be developed and produced.

The interpretation of these data to evaluate resource potential involves not only expertise using the latest state of the art but also highly sophisticated equipment. Under the present system, this expertise is found throughout many companies, each of which devotes a great amount of time and money to the development of better interpretative methods. Each company has its own interpretations and special knowledge, resulting in a diversity of approach to data analysis and use. Any company, as well as the Government, can miss the mark in evaluating a particular tract, but each company believes its competitive edge is its superior interpretation and use of data. Under a system where only the Government did exploratory drilling, the discovery rate could decline. Reserves which the Government underevaluated or overlooked might be less likely to be discovered.

The impacts of Government exploration would be essentially the same as industry's explorations. Industry is required to adhere to stringent standards developed by the Government and is inspected by Government employees enforcing those standards. It would be

inappropriate to believe the Government would make standards significantly more stringent for its own operations than it has for industry operations.

BIBLIOGRAPHY

Anderson, J.W.1973. Uptake and depuration of specific hydrocarbons from oil by the bivalves, Rangia cuneata and Crassostrea virginica. In Background Papers for a Workshop on Inputs, Fates and Effects of Petroleum in the Marine Environment. Vol 2. Prepared under the aegis of the National Academy of Sciences, Ocean Affairs Board, Washington D. C.

Baker, J. M. 1971. The effects of a single oil spillage. p. 16-20. In. E. B. Cowell (ed.) The ecological effects of oil pollution in littoral communities. Elsevier, London.

Bellamy, D. J., P. H. Clarke, D.M. John, D. Jones, A. Whittick, 1967. Effects of pollution from the Torrey Canyon on littoral and sublittoral ecosystems. Nature 216: 1170-1173.

Blumberg, R. 1964. Hurricane winds, waves and currents test marine pipeline design. Pipe Line Industry 20(6).

Blumer, M., M. M. Mullin and R. R. L. Guillard. 1970. A polyunsaturated hydrocarbon (3,6,9,12,15,18-heneicosahexaene) in the marine food web. Mar. Biol. 6: 226-235.

Blumer, M. 1969. Oil pollution of the ocean. p. 5-13. In D. P. Hoult (ed.) Oil on the sea. Plenum Press. New York.

Blumer, M, H. L. Sanders, J. F. Grassle and G. R. Hampton. 1971. A small oil spill. Environment 13: 2-12.

Blumer, M., G. Souza, and J. Sass. 1970. Hydrocarbon pollution of edible shellfish by an oil spill. Mar. Biol. 5: 195-202.

Boesch, D. S. 1973. Biological effects of chronic oil pollution on coastal ecosystems. In Background Papers for a Workshop on Inputs, Fates and Effects of Petroleum in the Marine Environment. Vol. 2. Prepared under the aegis of the Ocean Affairs Board, National Academy of Sciences. Washington, D.C.

Chan, G. 1972. A study of the effects of the San Francisco oil spill on marine organisms. Part I. College of Marin, Kentfield, California. 78 pp.

Charter, D. B., R. A. Sutherland, and J. D. Porricelli. 1973. Quantitative estimates of petroleum to the oceans. National Acad. of Sci., National Research Council.

Clark, R. B. 1973. Impact of acute and chronic oil pollution on seabirds. In Background Papers for a Workshop on Inputs, Fates, and Effects of Petroleum in the Marine Environment. Prepared under the aegis of the Ocean Affairs Board, National Academy of Sciences. Vol. 2. Washington, D.C.

Clark, R. C. 1973. Biological fates of petroleum hydrocarbons in aquatic microorganisms. In Background Papers for a Workshop on Inputs, Fates, and Effects of Petroleum in the Marine Environment. Vol. 2. Prepared under the aegis of the Ocean Affairs Board, National Academy of Sciences. Washington, D.C.

Connel, D. W. 1971. Kerosene-like tainting in Australian mullet. Australian Wine Research Institute. Glen Osmond, S. Australia.

Connel, D. W. 1971. Kerosene-like tainting in Australian mullet. Mar. Poll. Bull. 2: 188. Australian Wine Research Institute. Glen Osmond, S. Australia, 5064.

Cowell, E. B. 1969. The effect of oil pollution on salt-marsh communities in Pembrokeshire and Cornwall. J. Appl. Ecol. 6:133-142.

Cowell, E. B. and J. M. Baker. 1969. Recovery of a salt marsh in Pembrokeshire, South-west Wales, from pollution by crude oil Biol. Cons. 1:291-295.

Cowell, E. B. ed. Ecological effects of pollution on littoral communities, proceedings of a symposium organized by the Institute of Petroleum and Zoological Society of London 30,Nov. through 12, Jan, 1970. London Institute of Petroleum 250pp. Illust.

Ehrhardt, M. 1972. Petroleum hydrocarbons in oysters from Galveston Bay. Envir. Pol. (in press.).

Fauchald, K. 1971. The benthic fauna in the Santa Barbara Channel following the January, 1969, oil spill. p. 61-116. In. D. Straughan (ed.) Biological and oceanographic survey of the Santa Barbara Channel oil spill, 1969-1970. Vol. I. Biology and Bacteriology. Sea Grant Pub. No. 2. Allan Hancock Found. Univ. So. Calif. Los Angeles.

Foster, M., M. Neushul, and R. Zingmark. 1970. The Santa Barbara oil spill. II. Initial effects on littoral and kelp bed organisms. In Santa Barbara Oil Pollution, 1969. Government Printing Office, Washington, D.C.

Freegarde, M., C. G. Hatchard, and C.A. Parker. 1970. Oil spilt at sea; its identification, determination, and ultimate fate. In Laboratory Practice. Admir. Mater. Lab., England 20(1): 35-40.

Galtsoff, P. S. 1959. Environmental requirements of oysters. p. 128-134. In U.S. Dept. Health, Edu. Welfare. "Biological Problems in Water Pollution". Trans. sec. Seminar Biol. Prob. Water Poll., April 20-24, 1959. Cincinnati, Ohio.

George, J. D. 1970. Sub-lethal effects on living organisms. Partial Reprint, Marine Pollution Bull., pp. 107-109.

Gagliano, S. M., and J. L. van Beek, 1970, Geologic and geomorphic aspects of deltaic processes, Mississippi delta system. In (S. M. Gagliano, R. Muller, P. Light, and M. Al-Awady) Hydrologic and geologic studies of coastal Louisiana, La. State Univ., Coastal Studies Institute and Dept. of Marine Sciences, vol. I, 140 pp.

Gordon, D. C. and N. J. Prouse. 1972. The effects of some crude oil and refined oils on marine phytoplankton photosynthesis. ICES Report CM-E33. Charlottenlund, Danemark.

Hartung, R. W. 1967. The Santa Barbara oil spill. In Oil in the Sea. D. D. Hoult, ed. Plenum Press, New York.

Hartung, R. and G. S. Hunt. 1966. Toxicity of some oils to waterfowl. J. Wildlife Management. 30(3): 564-570.

Hufford, G. L. 1971. The biological response to oil in the marine environment. Project No. 714141/003 Rep. U.S. Coast Guard. Washington, D.C. 23 p.

Ingle, R. M. 1952. Studies on the effect of dredging operations upon fish and shellfish. Florida State Board of Conservation, Tech. Ser. No. [illegible]. [illegible] p.

Jones, I. I. and S. Williams. 1973. Trace elements in the bottom sediments of the OEI study area. In The Gulf Universities Research Consortium--Petroleum and Allied Industry Sponsored Offshore Ecology Investigation. Third Quarterly Scientific Report. GURC Report No. 126.

Keating, B. 1972. The Gulf of Mexico. Viking Press. N.Y. 126 pp.

Ketchum, B. H. 1973. Oil in the marine environment. In Background Papers for a Workshop on Inputs, Fates, and Effects of Oil in the Marine Environment. Vol. 2. Prepared under the aegis of the Ocean Affairs Board, National Academy of Sciences. Washington, D.C.

LaRoe, E. T. 1972. Comments on the environmental effects of oil drilling and production. Collier County, Florida, Convervancy.

Levorsen, A. I. 1958. Geology of petroleum. Freeman. San Francisco. 702 p.

Mackin, J. M. 1961. Canal dredging and silting in Louisiana bays. Pub. Inst. Mar. Sci. Univ. Texas. 7:262-314.

Mackin, J. G. 1971. A study of the effect of oil field brine effluents on biotic communities in Texas estuaries. Project No. 735. Texas A & M Res. Found. College Station. Texas. 72 p.

Mackin, J. G. and A. K. Sparks. 1962. A study of the effects on oysters of crude oil loss from a wild well. Texas A & M Univ. Inst. Mar. Sci. Pub. 7:230-261.

Mertens, E. W. 1973. A literature review of the biological impact of oil spills in marine water. In Background Papers for a Workshop on Inputs, Fates, and Effects of Petroleum in the Marine Environment. Vol. 2. Prepared under the aegis of the Ocean Affairs Board, National Academy of Sciences. Washington, D.C.

Mironov, O. G. 1967. Effects of low concentrations of petroleum and its products on the development of roe of the Black Sea flatfish. Vop. Ikhtiol. 7(3): 577-580.

Mironov, O. G. 1970. The effect of oil pollution on flora and fauna of Black Sea. Paper presented at Food and Agri. Org. Conf., Rome, Italy. December.

Mitchell, C. T., Anderson, E. K., Jones, L. G., North, W. L. 1970. What oil does to ecology. Journ. W.P.C.F. Vol. 42, No. 5, Pt. 1, pp 812-818.

National Transportation Safety Board. 1970. Explosions and fire on the Chambers and Kennedy offshore platform, block 189-L and fire on M/V Carryback in Gulf of Mexico. May 28, 1970. U.S. Dept. Transportation, Washington, D.C. 7 p.

Nelson, R. F. 1972. The Bay Marchand Fire. J. Pet. Tech. March, 1972. pp. 225-233.

Nicholson, N. L. and R. L. Cimberg. 1971. The Santa Barbara oil spill of 1969: a post-spill survey of the rocky intertidal. pp. 325-400. In. D. Straughan (ed.) Biological and oceanographic survey of the Santa Barbara Channel oil spill, 1968-1970. Vol. I. Biology and Bacteriology. Sea Grant Pub. No. 2. Allan Hancock Foundation. Univ. So. Calif. Los Angeles.

North, W. J. 1973. Position paper on effects of acute oil spills. In Background Papers for a Workshop on Inputs, Fates, and Effects of Oil in the Marine Environment. Vol. 2. Prepared under the aegis of the Ocean Affairs Board, National Academy of Sciences. Washington, D.C.

North, W. J., M. Neushul, and K. A. Clendenning. 1964. Successive biological changes observed in a marine cover exposed to a large spillage of mineral oil. Proc. Symp. Pol. Mar. Microorg. Prod. Petrol., Monaco. pp. 335-354.

Oguri, M. and R. Kantor. 1971. Primary productivity in the Santa Barbara Channel. pp. 17-48. In. D. Straughan (ed.) Biological and oceanographic survey of the Santa Barbara Channel oil spill: 1969-1970. Vol. I. Biology and Bacteriology. Sea Grant Pub. No. 2. Allan Hancock Foundation. Univ. So. Calif. Los Angeles.

Onuf, C. P. 1973. An analysis of the main scientific papers dealing with long-term, low-level effects of oil pollution. In Background Papers for a Workshop on Inputs, Fates, and Effects of Petroleum in the Marine Environment. Vol. 2. Prepared under the aegis of the Ocean Affairs Board, National Academy of Sciences. Wash., D.C.

Operation Oil. 1970. Report of the task force - Operation Oil (Clean-up of the Arrow oil spill in Chedabucto Bay) to the Minister of Transport. Atlantic Oceano. Lab. Bedford Inst. Dartmouth, Nova Scotia.

Porricelli, J. D., V. F. Keith, and R. L. Storch. 1971. Tankers and the ecology. In. Navigable waters safety and environmental quality act. Hearings before the Committee on Commerce,United States Senate. 92nd Congress. September 22, 23, and 24, 1971. Serial No. 92-39.

Porricelli, J. D., and V. F. Keith. 1973. Tankers and the U. S. energy situation--an economic and environmental analysis. For presentation at the Intersociety Transportation Conference, Denver, Colorado, September 24-27, 1973, of the Intersociety Committee on Transportation.

Randall, J. E. 1963. An analysis of the fish population of artificial and natural reefs in the Virgin Islands Caribbean. J. Sci. 3:31-47.

Ray, S. M. 1971. Critique of Report on Studies and Investigation of the Shell Oil Spill. U.S. Department of Interior Public Hearing. Sheraton Charles Hotel - New Orleans, Louisiana, August 22-23, 1972.

Reinhart, P. W. 1970. Oil seepage potentialities of Dos Cuadras oil field, Santa Barbara County, California. Santa Barbara Environmental Quality Advisory Board. 31 p.

Resources Technology Corporation, 1971, Studies and Investigations of the Fate and Effect of the Shell Oil Spill, Platform B. Block 26, S. Timbalier Bay, 1970. Contract 68-01-0051 for the Environmental Protection Agency. Houston, Texas.

Rice, S. D. 1973. Toxicity and avoidance tests with Prudhoe Bay oil and pink salmon fry. Proc. Joint Conf. Prev. Contr. Oil Spills. Washington, D.C. pp. 667-670.

St. Amant. L. S. 1970. Biological effects of petroleum exploration and production in coastal Louisiana. Santa Barbara Oil Symposium University of California at Santa Barbara, Santa Barbara, California.

St. Amant, L. S. 1971. Impacts of oil on the Gulf Coast. Louisiana Wildlife and Fisheries Commission, New Orleans, Louisiana.

St. Amant, L. S. 1972. The petroleum industry as it effects marine and estuarine ecology. J. Pet. Tech. 24:385-392.

St. Amant, L. S. 1973. Some consideration of the chronic effects of petroleum in the marine environment. In Background Papers for a Workshop on Inputs, Fates, and Effects of Petroleum in the Marine Environment. Vol. 2. Prepared under the aegis of the Ocean Affairs Board, National Academy of Sciences. Washington, D.C.

Sanders, H. L. 1973. Some biological effects related to the West Falmouth oil spill. In Background Papers for a Workshop on Inputs, Fates, and Effects of Petroleum in the Marine Environment. Vol. 2. Prepared under the aegis of the Ocean Affairs Board, National Academy of Sciences. Washington, D.C.

Sanders, H. L., J. F. Grassle, and G. R. Hampson. 1972. The West Falmouth oil spill. Part I. Biology. Woods Hole Oceanographic Institution Tech. Rep. No. WHOI-72-20. 49 p. (Unpublished Manuscript.)

Scarratt, D. J. 1971. Incidence of Bunker C in common benthic animals and sediments. Contrib. Oil Pol. Workshop. Nova Scotia Technical College. Halifax. pp. 4-12.

Shelton, R.G. J. 1971. Effects of oil and oil dispersals on the marine environment. Proc. Roy. Soc. London. B. 177: 411-422.

Spears, R. W. 1971. An evaluation of the effects of oil, oilfield brine and oil removing compounds. In. American Institute of Mining. Metallurgical and Petroleum Engineers. AIME Environmental Quality Conference. June 7-9, 1971, Washington, D. C., pp. 199-216.

Spooner, M. 1969. Some ecological effects of marine oil pollution. pp. 313-316. Proc. Joint Conf. Prev. Contr. Oil Spills, December 15-17. New York.

Spooner, M. 1970. Oil spill in Tarut Bay, Saudi Arabia. Mar. Poll. Bull. No. 1, pp. 166-167.

Stone, J. H. 1972. Final Report on "Preliminary assessment of the Environmental Impact of a Superport on the Southeastern Coastal Area of Louisiana." Draft Copy. Center for Wetlands Resources. Louisiana State University Baton Rouge, Louisiana.

Straughan, D. 1971. Oil pollution and seabirds. pp. 307-312 In. D. Straughan (ed.) Biological and oceanographic survey of the Santa Barbara Channel oil spill, 1969-1970. Vol. I. Biology and Bacteriology. Sea Grant Pub. No. 2. Allan Hancock Foundation. Univ. S. California. Los Angeles.

Straughan, D. and R. L. Kolpack (ed.) 1971. Biological and oceanographic survey of the Santa Barbara Channel oil spill, 1969-1970. Allan Hancock Foundation. Univ. So. California. Sea Grant Pub. No. 2., 2 Vols.

Teal, J. M. and J. J. Stegeman. 1973. Accumulation, release and retention of petroleum hydrocarbons by the oyster, Crassostrea virginica. In Background Papers for a Workshop on Inputs, Fates, and Effects of Petroleum in the Marine Environment. Vol. 2. Prepared under the aegis of the Ocean Affairs Board, National Academy of Sciences. Washington, D.C.

Texas Instruments Inc. 1971. Oceanographic and Remote Sensing Survey in the vicinity of the Shell Spill - Gulf of Mexico, January 1971. Contract #68-01-0017. Report prepared by J. A. Watson, S. A. Terry, and F. J. Buckmeier for Environmental Protection Agency.

Thomas, M. L. H. 1973. Effects of Bunker C oil on intertidal and lagoonal biota in Chedabucto Bay, Nova Scotia. J. Fish. Res. Board of Canada. Vol. 30 No. 1, pp. 83-90.

Trask, T. 1971. A study of three sandy beaches in the Santa Barbara, California area. pp. 159-178. In. D. Straughan (ed.) Biological and oceanographic survey of the Santa Barbara Channel oil spill, 1969-1970. Vol. I. Biology and Bacteriology. Sea Grant Pub. No. 2. Allan Hancock Foundation. Univ. So. Calif. Los Angeles.

U. S. Department of Commerce. 1971a. Shrimp Landings, South Atlantic and Gulf States, 1967-69. National Marine Fisheries Service. Current Fisheries Statistics No. 5407. Washington, D.C.

U. S. Department of Commerce. 1971b. Shrimp Landings, Annual Summary 1970. National Marine Fisheries Service. Current Fisheries Statistics No. 5722. Washington, D.C.

U. S. Department of Commerce. 1973. Gulf Coast Shrimp Data, Annual Summary 1971. National Marine Fisheries Service. Current Fisheries Statistics No. 5925. Washington, D.C.

U. S. Department of Interior. 1970. Interim evaluation of environmental impact from the Chevron Company fire and oil spill of coastal Louisiana. A report issued by the Assistant Secretary for Fish, Wildlife and Parks, Washington, D.C. 38 p.

U. S. Department of the Interior. 1974. United States list of endangered fauna. Fish and Wildlife Service, Washington, D. C.

U. S. Fish and Wildlife Service. 1968. Shrimp landings. Current Fisheries Statistics No. 4775. U. S. Dept. of Interior. Washington, D.C. 17 p.

U. S. Fish and Wildlife Service. 1970. Shrimp landings. Current Fisheries Statistics No. 5132. U. S. Dept. Interior, Washington, D. C. 16 p.

Vale, G. L., G. S. Sidu, W. A. Montgomery, and A. R. Johnson. 1970. Studies on a kerosene-like tainting in mullet. I. General nature of the taint. J. Sci. Agric. 21: 429-432.

Valentine, J. 1970. Proposed refuge land acquisition, Isles Dernieres, Terrebonne Parish, Louisiana. Bureau of Sport Fisheries and Wildlife. U. S. Department of the Interior, Lafayette, Louisiana.

Zobell, C. E. and J. H. Prokop. 1966. Microbial Oxidation of Mineral Oils from Barataria Bay Bottom Deposits. Scripps Inst. Oceanography. Condri. #2047.